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UNITED STATES DEPARTMENT OF AGRICULTURE Economic Research Service

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(Continued on inside back cover.)

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A Recursive Model of the Hog Industry

By Arthur A. Harlow

There are a number of estimation methods available to the econometrician. They range in complexity from least squares, which takes only a few minutes with pencil and paper for a simple problem, to full information maximum likelihood, which requires a large-capacity electronic computer for effective application. A list of the common methods, given in order of increasing complexity, includes least squares, two-stage least squares, instrumental variables, limited information, and full information. Recursive systems are fitted by least squares which makes estimation relatively simple, and they have other desirable statistical properties. Following a brief discusssion of the special characteristics of recursive systems, this paper presents an application of the recursive method to an analysis of the hog industry. The author is indebted to Anthony S. Rojko and Hyman Weingarten of the Economic Research Service for their helpful suggestions during the preparation of this paper.

THE STATISTICAL properties of recursive models have been discussed for a number of years, a recent proponent being Herman Wold. But for all the theoretical examination of the method, only a few empirical applications have been made, notably those of Wold (*18*)[1] and Barger and Klein (*1*). Performance under actual conditions is a valuable criterion for evaluating theoretical systems.

Wold (*19*) has shown that under certain conditions recursive systems fitted by least squares produce maximum likelihood estimates of the structural coefficients. This is in addition to the unbiased estimates of the dependent variable that the least squares method normally gives. Maximum likelihood estimates have certain optimum properties that recommend them to the statistician. The estimates are consistent—it is unlikely that in large samples there would be any great difference between the estimate and the true value. They are also efficient in the sense that for large samples they have a smaller variance or standard error than any other estimate when the observations are from a normal population.

In order to give some basis for evaluating the performance of the method, a simple econometric model is described and the special characteristics of recursive systems briefly discussed.

Characteristics of a Recursive Model

A single equation regression model that assumes no errors of measurement in the observed variables can be written in the following form:

$$y_t = b_1 x_{1t} + b_2 x_{2t} + \ \ldots \ + b_k x_{kt} + u_t.$$

The dependent variable y and the independent variables x_1, x_2 . . . x_k are observed; the disturbance u is an unobservable random variable. The index t runs from 1 to N—there are N observations in the sample. The b's are constant but unobservable coefficients of the independent variables. The usual procedure is to estimate b_1, b_2 . . . b_k, and to make confidence statements about the estimates from the given sample.

Similar definitions are used for multiple equation systems, although an additional problem arises when there is a simultaneous relationship between two or more variables in the system. This would occur, for example, when supply and price affect each other within the given time period. Under the condition of a simultaneous relationship between two variables, the use of a single regression equation fitted by least squares may result in a statistical bias in the estimation of the b coefficients as indicated by Haavelmo (*9*). To avoid this bias, a system of equations should be solved simultaneously. In these equation systems, the variables are commonly divided into two categories—endogenous variables and predetermined variables. The former are those variables whose relationships among themselves and with other variables are to be determined from knowledge of the predetermined variables whose values are assumed to be known. These two categories thus correspond with the dependent and inde-

[1] Italic numbers in parentheses refer to Literature Cited, page 11.

pendent classification in a single regression equation.

Certain assumptions must be made about the disturbances u_t in order to simplify computation and to obtain estimates of the coefficients with desirable statistical properties such as consistency and efficiency. The following assumptions are commonly made for most methods of estimation: u_t is a normally distributed random variable with zero mean and constant variance; u_t is distributed independently of the predetermined variables; and successive disturbances are distributed independently of one another, or in other words, u_t is not serially correlated.

A recursive system consists of a set of equations each containing a single endogenous variable other than those that have been treated as dependent in prior equations. The endogenous variables enter the system one by one, like links in an infinite chain where each link is explained in terms of earlier links. The explanation proceeds recursively, link by link, from one period to the next, and within each period in a specified order.

The general mathematical condition for the use of the recursive method is that the Jacobian of the transformation connecting the disturbances with the endogenous variables be triangular and equal to one. The Jacobian of the transformation is the matrix of partial derivatives of u_t with respect to y_t. This general condition may seem quite complicated, but there is a simple method of testing it. If the structural equations in a system are linear in the variables, the elements of the Jacobian are identical with the coefficients of the endogenous variables. So when these coefficients form a triangular matrix, the general condition is met.

In order for the least squares parameter estimate of the recursive system to be consistent and efficient, certain assumptions concerning the disturbances must be met. One of the assumptions is that they are independent of the predetermined variables in the equation. This can be met by assuming that the covariance matrix Σ of the residuals u_t is diagonal. This means that the covariance matrix has zeros everywhere except on the diagonal, i.e., u_t has constant nonzero variance and zero covariance. Thus the disturbance of one equation is not correlated with the disturbance in any other equation of the model in the same time period. This additional assumption permits the use of actual rather than calculated values in the estimating equations. It also leads to maximum likelihood estimates by the single equation least squares method in a recursive model.

However, if the disturbances in the several equations in a system are correlated with one another, they are also correlated with variables that were dependent in preceding equations of the system, since by definition a dependent variable in a particular equation is assumed to be correlated with the disturbances in that equation.

One way to overcome this correlation is to use calculated values for endogenous variables serving as independent variables in succeeding equations. Calculated values for a dependent variable in an equation are known to be uncorrelated with the disturbances in that equation because the residuals are ignored in the computation. Hence calculated values for an endogenous variable obtained from one equation are uncorrelated with the disturbances in another equation within the same system.

With triangularity of the Jacobian but no restrictions on the Σ matrix, single equation least squares estimates are not necessarily also maximum likelihood estimates. Successive application of least squares methods to separate equations using calculated values of previously dependent variables leads to consistent but not efficient estimates in this case. This method is not recommended for large systems with a long chain of substitution of results from some equations into others. The accumulation of errors may eventually become prohibitive.

In many cases it does not appear justified to assume the diagonality of the covariance matrix. This assumption is clearly inapplicable in the following situations: (1) In a given year, all observations were subject to larger than usual errors because the funds available for the collection of statistics were less than normal. (2) One variable, such as national income, is affected by errors of aggregation (perhaps due to shifts in distribution), and this variable enters several equations of the model. (3) Omitted variables are known to affect two or more equations—for instance, weather affects all crop production. On the other hand, if two crops are grown in widely separated areas, the inclusion of weather in the random disturbances is permissible because relatively independent drawings of weather affect the two crops.

But unless there is a specific reason for assuming that the Σ matrix is not diagonal, it is usually worthwhile to make this assumption because this can reduce computations for maximum likelihood estimates by a factor of 2 or 3 for a model of 3 equations and by a much greater factor for larger systems.

Formulation of the Model

In formulating an econometric model, the nature of the economic system to be analyzed should determine the type of equations to be used and the method used in fitting them.

The initial task in analysis is thus to determine the nature of the economic system under consideration. Wold (*17*) believes that many economic systems are of the recursive type, whereas certain other econometricians believe that systems of simultaneous relations are more typical. But regardless of which type is more prevalent, cobweb models are considered to fall into a recursive pattern, and it is generally agreed that hog production is a fairly good example of a cobweb phenomenon.

As an extremely simplified example, hog production can be described as a cobweb model where price in one period affects production in the next, which in turn affects price, and so on. The equations for a simple cobweb model where consumption equals production are

$$Q_t = aP_{t-1} + u_t$$
$$P_t = bQ_t + v_t$$

These two equations are linear in the variables and the matrix of the coefficients of the endogenous variables is triangular, so it satisfies the conditions for a recursive system. Of course, a more complete model would include more variables and more equations. Such a model is presented later in this paper.

The time devisions used in the analysis have considerable effect on the simultaneity of the determination of variables. With short time units, a recursive or causal chain system might be more appropriate than a simultaneous equation system. But when substantial units of time, such as a year, are used, more variables have time to interact and hence the simultaneous system is perhaps preferable.

Thus, in a recursive model, quarterly data are often preferred to annual observations. However, in quarterly models serial correlation in the disturbance terms tends to become more of a problem than when annual data are used. Barger and Klein (*1*) have attempted to solve this difficulty by randomizing the disturbance terms through autoregressive schemes. But the use of such schemes amounts to an admission that an economic explanation for a systematic part of the movement in the dependent variable has not been found.

The omission of relevant variables is an important reason for the existence of serial correlation in the residuals. Economic variables tend to be serially correlated. When some relevant economic variables are omitted from a structural equation, their effects on the dependent variable are left with the unexplained residuals. As a result, the residuals are also serially correlated. An attempt to deal with this difficulty would thus require the inclusion of more explanatory variables in the structural relationships. These additional variables may be either current or lagged.

Nerlove and Addison (*13*) have found that the inclusion of the lagged quantity of a given commodity in its demand and supply functions is not only theoretically sound but that it also reduces serial correlation in the estimated residuals to insignificant levels. In the supply functions of agricultural products, lagged variables probably play a more important part than do current variables. In the case of demand functions, however, a number of current variables, such as current prices of competitive and complementary products, may be at least as important as lagged quantity as explanatory variables. And they may also significantly reduce serial correlation in the residuals.

The following six equations, fitted by least squares to quarterly data for 1949 through 1959, form a recursive system based on an expansion of the simple cobweb model given earlier. Although there are now additional variables and more equations, production is still basically a function of lagged price, and price is a function of present production. As intermediate steps, there are now equations for the number of sows farrowing, hogs slaughtered, cold storage holdings of pork, and farm price of hogs.

$$(1)\quad F = -1163.260 + \underset{(.032)}{0.994}F_{t-4} + \underset{(20.100)}{28.716}P_{H_{t-1}}$$
$$- \underset{(336.756)}{714.202}P_{C_{(4)t-1}} - \underset{(11.275)}{19.509}P_{B_{(4)t-1}}$$

$$+15.282G_{y-1}+84.350P_{H(4)y-1}$$
$$(7.678) \qquad (21.002)$$

$$R^2=0.965$$
$$d=1.840^{\Delta}$$

(2) $$H=10583.172+3.101F_{t-2}$$
$$(.170)$$
$$-9010.958D_{(3)}+58.125T$$
$$(477.373) \qquad (15.134)$$

$$R^2=0.927$$
$$d=1.287^{*}$$

(3) $$Q_P=313.377+0.128H-2.584R$$
$$(.002) \quad (1.213)$$

$$R^2=0.994$$
$$d=1.278^{\circ}$$

(4) $$S=-750.755+0.218Q_{P_{t-1}}+0.890S_{t-1}$$
$$(.028) \qquad (.058)$$
$$+6.448P_{P_{t-1}}-1.358W_{t-1}$$
$$(2.048) \qquad (.378)$$

$$R^2=0.906$$
$$d=2.006^{\Delta}$$

(5) $$P_P=103.127-1.249\frac{Q_P}{N}-2.841\frac{S}{N}$$
$$(.155) \qquad (.461)$$
$$-0.419\frac{Q_B}{N}-0.678\frac{Q_R}{N}-0.017\frac{I}{N}$$
$$(.194) \qquad (.431) \qquad (.017)$$
$$-6.613D_{(55)}-0.026W$$
$$(1.126) \qquad (.013)$$

$$R^2=0.873$$
$$d=1.298^{*}$$

(6) $$P_H=-8.933+0.602P_P-0.044M-0.009W$$
$$(.029) \qquad (.012) \qquad (.003)$$

$$R^2=0.945$$
$$d=1.332^{*}$$

$^{\Delta}$No serial correlation in residuals.
*Inconclusive test for serial correlation in residuals.
°Positive serial correlation in residuals.

The Durbin-Watson statistic (d) provides a test for the presence of serial correlation in the residuals, i.e., the degree of correlation of each residual with the residual for the previous year. The table for the Durbin-Watson test extends only to five independent variables. For equations with more independent variables, a linear extrapolation was used. The degree of serial correlation is indicated by the symbols given above.

In general, the mnemonic device of denoting each variable by its first letter is followed, although there are some exceptions to prevent duplication. All price variables are measured in constant prices by deflating them by the consumer price index. Unless otherwise specified, quarterly data are used. For lagged variables, $t-1$, $t-2$, and so on, indicate the number of quarters lagged, and $y-1$ indicates a yearly lag. For instance, $P_{C(4)y-1}$ refers to the price of corn in the fourth quarter of the previous year.

Variables are defined as follows:

F=sows farrowing (1,000 head)
P_H=deflated price received by farmers for hogs (dol. per cwt.)
P_C=deflated price received by farmers for corn (dol. per bu.)
P_B=deflated price received by farmers for beef cattle (dol. per cwt.)
G=annual production of barley, oats, and grain sorghum (mil. tons)
H=hogs slaughtered (1,000 head)
D=dummy variable (0 or 1 in different periods)
T=time (1, 2, 3, . . . in successive quarters)
Q_P=quantity of pork produced (mil. lbs.)
S=cold storage holdings of pork, beginning of quarter (mil. lbs.)
P_P=deflated retail price of pork (cents per lb.)
W=seasonal index, based on mean quarterly temperatures
Q_B=quantity of beef produced (mil. lbs.)
R=ratio of pigs saved fall $y-1$ to spring y
Q_R=quantity of broilers produced (mil. lbs.)
N=U.S. population (mil.)
I=deflated discretionary income (mil. dol.)
M=Index numbers of unit marketing charges (1947–49=100)

Discussion of the Variables

The basic supply equation of the simple cobweb model has been expanded into three equations to reflect some of the steps in the production process. There are no data on sows bred but there are estimates of the number of sows farrowing, and most bred sows are held for farrowing. Factors that influence the number of sows farrowing include the facilities available on farms for raising hogs, the expected price of hogs at marketing time, the

price and supply of feed, and the relative profitability of alternative uses of farm resources used in hog production, mainly feed and labor. Since this analysis uses quarterly data, some provision for the seasonal pattern of farrowings is also needed.

One way of accounting for the equipment available for hog production as well as the seasonal pattern is to include the farrowings for the same quarter of the previous year as an explanatory variable. Various studies have indicated that farmers make their basic decisions concerning next year's hog production in the fall. Thus the prices of hogs, corn, and beef cattle—the latter being the main competitor of hogs for feed and labor—for the fourth quarter of the previous year are included. But conditions may change during the year so the prices of these three commodities lagged one quarter were also tried as explanatory variables. Since the gestation period for hogs from breeding to farrowing is about 4 months, a 3-month lag is not precise, but it is the closest approximation possible using quarterly data. The previous year's production of small grains (oats, barley, and sorghum) affects farrowings during the first two quarters, while the present year's production influences third and fourth quarter farrowings.

Intercorrelation resulted in wrong signs and insignificant coefficients for corn and beef prices lagged one quarter, hence these variables were dropped from the equation. The effects of intercorrelation (that is, correlation between independent variables) upon correlation and regression coefficients are discussed by Fox and Cooney (*6*). In general, high intercorrelation tends to mean lowered reliability for individual regression coefficients.

All regression coefficients in equation (1) have the correct sign and all are larger than their standard errors, although they are not all significantly different from zero at the 5 percent level. This is the standard significance level used in this study—it means that a coefficient has a 95 percent probability of being different from zero and five chances out of a hundred that it is not different from zero. The d statistic for the Durbin-Watson test for serial correlation in the residuals shows no serial correlation.

The number of hogs slaughtered depends upon the number of sows farrowing 6 to 8 months previously and the number of pigs raised per sow. The age of barrows and gilts at marketing varies from 5 to 10 months; therefore it is difficult to achieve a precise determination of the lag between farrowing and marketing. But most hogs are slaughtered at 6 to 8 months, so a two-quarter lag was used. As the number of pigs raised per sow has been increasing in recent years at a fairly steady rate, time was used as a variable to account for this trend. Graphic analysis of the data revealed that estimates of third quarter slaughter based on lagged farrowings were considerably higher than actual slaughter. Many gilts are retained for breeding purposes in the early fall months, and consequently slaughter is reduced. Also, the predominance of March farrowings in the first quarter and the tendency to feed spring pigs longer than fall pigs before marketing mean that many pigs farrowed in the first quarter are not marketed until the fourth. To account for this, a dummy variable was introduced having a value of 1 for the third quarter where there were fewer marketings, and 0 for other quarters when conditions were normal.

All three regression coefficients are significant and have the expected signs. The d statistic is within the inconclusive range.

The quantity of pork produced depends upon the number of hogs slaughtered, their average slaughter weight, and their dressing yield. The latter is virtually stable and therefore does not create changes in pork production. The average slaughter weight varies seasonally and from year to year.

The year-to-year variation in slaughter weights results from different quantities fed, and this may be caused by hog prices or grain supplies. Also, spring farrowed pigs are usually fed longer and to heavier weights than fall pigs. Thus in a year when the number of spring pigs slaughtered is proportionately larger, the average slaughter weight would be expected to increase, and vice versa. Pigs farrowed in the fall are marketed during the following spring and summer, whereas most spring pigs are marketed in the fall of the same year. A ratio of pigs saved in the fall of the preceding year to the number of pigs saved in the spring is therefore included as a variable. The negative sign for this variable means that as the proportion of fall pigs marketed during the year increases, the quantity of pork produced decreases

when the number of hogs slaughtered remains constant.

No satisfactory method was found for accounting for the seasonal variation in slaughter weights. The absence of any measure for this variable in the equation is one likely reason for the positive serial correlation in the residuals.

Since it was found that cold storage holdings of pork at the beginning of a quarter have an effect on the retail price of pork during that quarter, a storage estimating equation was necessary. A certain quantity of pork is always in cold storage owing to curing processes and the normal delay between slaughter and consumer purchase. Cold storage holdings lagged one quarter are used to account for these factors. The quantity of pork produced during the previous quarter also influences the quantity in storage, as do price and the season of the year.

The seasonal variation may perhaps be accounted for by using a seasonal index of temperature variation. This is simply the average temperature for each quarter as a percentage of the "normal" annual temperature. Estimates of average U.S. temperatures are used in computing the index, admittedly a rough approximation, yet one that gives some indication of variation due to the changing seasons.

All of these factors are significant and the d statistic indicates no serial correlation in the residuals. The sign of the price coefficient is somewhat surprising as it indicates that storage holdings increase as price increases. We might expect that storage would be reduced when prices were high. However, there is probably some interaction between price and storage within a quarter, and with other variables held constant, it may be that a price increase accompanies an increase in stocks, because when stocks increase the quantity marketed decreases.

On the demand side, price analysis for agricultural commodities is frequently centered at the retail level. In the short run, prices of the more basic commodity are regarded as derived primarily from the price as determined for the retail product. As Thomsen (*15*, p. 52) states it: "The demand for products at the farm end of the marketing system consists of consumer demand (i.e., prices which consumers will pay for different quantities) minus a schedule of marketing charges . . . ."

Using this approach, the retail price is estimated first and the farm price is derived from it. The retail price of pork is affected by the supply of pork available for consumption, the supply of competing meats, and consumer income. These variables are put on a per capita basis to allow for population increase. The supply of pork consists of the quantity in storage at the beginning of a quarter plus production during the quarter. The major competing meats are beef and broilers. As storage of these meats is small, the available supply is approximately equal to production. Deflated discretionary income is used as a measure of consumer income because it is not so highly correlated with the other predetermined variables as is disposable income.[2] As was mentioned earlier, high intercorrelation among the predetermined variables makes interpretation of their coefficients difficult because it increases standard errors and sometimes changes the signs of the coefficients. Graphic analysis of the data shows a shift in demand for pork occurring in 1955, so a dummy variable having a value of 0 from 1949 through 1954 and a value of 1 from 1955 to 1959 was used to account for this shift. Stanton (*14*) has shown that there is a seasonal difference in the demand for pork, therefore the previously described seasonal index is included as a variable.

All coefficients are larger than their standard errors except that for discretionary income. The sign for the income coefficient indicates that as income rises, the price of pork falls. But since the coefficient is not significantly different from zero, the sign means very little, if anything. All other signs are as expected. The sign for the dummy variable indicates a downward shift in the demand for pork. The seasonal factor shows a decrease in price during the warmer spring and summer quarters, other things constant. The coefficient for broiler production is not significant.

[2] Discretionary income is derived from disposable income by subtracting the essential expenses associated with the relatively high standard of living achieved in the postwar years. The items deducted from disposable income include major fixed commitments such as rent, taxes, home mortgage and installment debt repayments, and essential expenditures including medical expenses, household utilities, local transportation, and the maintenance of a given level of food and clothing consumption. For a full explanation of the concept of discretionary income and the procedures for its calculation, see Franklin (7).

The rest of the coefficients (except that for income) are more than twice their standard errors and are significant at accepted probability levels. The d statistic is in the inconclusive range.

The farm price of hogs is derived from the retail price and a marketing margin. Index numbers of unit marketing charges are used as a measure of this margin. The margin varies seasonally, increasing during the summer. All three variables have the expected sign and are significantly different from zero at the 5 percent level. The test for serial correlation of the residuals is again inconclusive.

Evaluation of the Model

This system of six equations is not linear in the variables because in equation (5) pork production and storage have been converted to per capita bases after being used as total figures in other equations. Therefore, the matrix of the coefficients of the endogenous variables does not equal the Jacobian, and the latter will have to be computed in order to determine whether the general condition for recursive treatment is met. The Jacobian is

$$|J|=\frac{\partial(u_1, u_2, u_3, u_4, u_5, u_6)}{\partial(F, H, Q_P, S, P_P, P_H)}=$$

$$\begin{vmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0.128 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & \frac{-1.240}{N} & \frac{-2.841}{N} & 1 & 0 \\ 0 & 0 & 0 & 0 & 0.602 & 1 \end{vmatrix} = 1,$$

so the general condition is fulfilled.

The Jacobian contains unknown values of the variable N, but since it is a triangular matrix, its determinantal value is the product of the elements along the main diagonal which equals unity. Thus in this case, there is no need to develop linear approximations of the nonlinear variables in order to evaluate the Jacobian.

Residuals are estimates of the unobservable disturbances u_t. The assumptions made earlier about the u_t do not necessarily apply to the residuals $\hat{u}_t$. If the equations have been properly formulated, however, the residuals should have the same properties as were assumed for the disturbances.

Testing for serial correlation in the residuals has become fairly common in time series analysis—it has been shown that serious errors and biases may result if residuals are autocorrelated. Nonindependence of residual terms from an equation fitted by least squares leads to loss of statistical efficiency, underestimation of the true variance by the usual formula, and invalid $t-$ and $F-$ tests; it does not lead to statistical bias or inconsistency (Foote, *5*). For equations utilizing lagged dependent variables as explanatory variables, Hurwicz (*12*) has demonstrated that least squares estimates of coefficients are biased in small samples. But provided the residuals are not autocorrelated, these estimates of the parameters are consistent. If the residuals for these equations are autocorrelated, least squares estimates of the parameters may be seriously biased even in large samples (Griliches, *8*).

A completely satisfactory test for serial correlation in residuals has not yet been devised. A simple correlation between $\hat{u}_t$ and $\hat{u}_{t-1}$ too frequently accepts the hypothesis that they are independent. In other words, the correlation coefficient will sometimes be nonsignificant when the sample has been drawn from a serially correlated population. Durbin and Watson (*2*) derived some approximate tests for autocorrelation in successive residuals of least squares regression models. The tests do not apply to models that use lagged values of the dependent variable as independent variables (*2*, p. 410). The d statistic computed from the residuals of such a regression often accepts the false hypothesis of nonautocorrelated errors. The test also has a considerable range of indeterminancy.

Durbin and Watson (*3*) present an approximate procedure for use when their bounds test is inconclusive. This method involves transforming $(1/4)d$ to a Beta distribution and should be sufficiently accurate with a large number of degrees of freedom, say greater than 40. As the transformation requires lengthy computations and gives only a rough approximation for small samples, it is rarely used.

Although two of the six equations in the model use lagged values of the dependent variable for independent variables (equations (1) and (4)), the Durbin-Watson test is used to give some indication of the degree of serial correlation in the residuals for these analyses. The test indicates that the condition of serial independence of the residuals is relatively well met for a quarterly system.

There is only one case of positive serial correlation; there are three cases where the test is inconclusive and two cases of no autocorrelation. The two cases of nonautocorrelation are suspect, however, because these equations include lagged values of the dependent variable.

A common method of testing for independence between two distributions is to compute the correlation coefficient. Absence of linear correlation, however, is not proof of independence (*4*, p. 222). But for want of a more precise test for the independence of the residuals from different equations, a correlation matrix for the $\hat{u}$'s was used to measure the degree of independence. The diagonality of the covariance matrix Σ can be determined from this matrix since

$$r_{12}=\frac{\text{covariance } x_1\ x_2}{\sqrt{(\text{variance } x_1)\ (\text{variance } x_2)}}$$

If there is no correlation between the $\hat{u}$'s, the $r_{ij}=0$, and the covariances are also zero, making the Σ matrix diagonal. The correlation matrix for the residuals of the six equations is:

	$\hat{u}_1$	$\hat{u}_2$	$\hat{u}_3$	$\hat{u}_4$	$\hat{u}_5$	$\hat{u}_6$
$\hat{u}_1$	1.000	0.055	0.027	0.103	0.161	0.061
$\hat{u}_2$	-----	1.000	.124	.083	.013	.130
$\hat{u}_3$	-----	-----	1.000	.141	.037	.194
$\hat{u}_4$	-----	-----	-----	1.000	.002	.019
$\hat{u}_5$	-----	-----	-----	-----	1.000	.183
$\hat{u}_6$	-----	-----	-----	-----	-----	1.000

The residuals from different equations may be assumed to be independent because none of the correlation coefficients is significantly different from zero at the 5 percent level. The assumption of a diagonal covariance matrix and the use of actual values of endogenous variables serving as predetermined variables in subsequent equations appear to be justified.

Inclusion of Additional Variables

In an attempt to reduce the serial correlation in the residuals, the model was altered slightly by including more explanatory variables in the equations. The method of determining the appropriate variables to include in the equations was to compute a correlation matrix of the residuals and the predetermined variables used in the system. An examination of this matrix showed that no predetermined variables are correlated significantly with $\hat{u}_1$. The residuals of the other five equations, however, are correlated with at least one of the predetermined variables used in other equations of the system. After selecting the correlated variable that made the most economic sense in each case, equations (2) through (6) were refitted using these additional variables.

Four predetermined variables are significantly correlated with $\hat{u}_2$. As would be expected, they are highly intercorrelated since they are each correlated with the same variable. Of the four, the price of hogs for the previous quarter was the most appropriate to include as an explanatory variable for the number of hogs slaughtered.

Since slaughter hogs can vary in age from 5 to 10 months, some response to price would be expected. A high price during the previous quarter would induce farmers to sell their hogs at that time. This would reduce the number of hogs sold in the present quarter. Conversely, there would be an increase in hogs slaughtered in the present quarter with low prices during the preceding quarter. Thus a negative regression coefficient would be expected.

The inclusion of this variable in equation (2) increases the multiple coefficient of determination to 0.94 and eliminates serial correlation in the residuals as measured by the Durbin-Watson statistic. The sign of the regression coefficient is negative as expected.

The residuals of equation (3) are significantly correlated with only one predetermined variable, the price of corn in the fourth quarter of the preceding year. It seems reasonable that the price of feed would influence the quantity of pork produced. A low corn price would lead to increased feeding and heavier hogs. When this variable is included in the equation, its coefficient is significantly different from zero with the expected negative sign. Serial correlation in the residuals is reduced so that the d statistic now falls in the inconclusive range.

The residuals of equation (4), which estimates the storage of pork at the beginning of a quarter, are correlated with four predetermined variables. The estimates for third-quarter beginning storage were consistently low, so the dummy variable for the third quarter was included as an additional variable. The other three correlated variables could not reasonably be included in the equation on economic grounds.

One reason for the higher than estimated storage for the beginning of the third quarter may be that packers and wholesalers increase storage holdings at this time in anticipation of smaller supplies

and higher pork prices during the summer. In any event, the addition of this variable increases the R^2 to 0.94 and the d statistic still indicates that there is no serial correlation in the residuals.

Of the two variables correlated with $\hat{u}_5$, the price of hogs during the previous quarter seemed most appropriate. The introduction of this variable into the equation for the retail price of pork means that pork prices are not completely determined by consumer demand as was previously hypothesized. Retail prices are somewhat "sticky" and for short periods may reflect the prices retailers paid for the pork now on their counters. Thus if the price of hogs was high the previous quarter, the price of pork would tend to be higher than it would be otherwise.

The addition of this variable changes the sign of the income coefficient to positive, but the coefficient is still not significantly different from zero. It also increases the R^2 to 0.92 and reduces serial correlation in the residuals. The d statistic is now at the upper end of the inconclusive range. The coefficient of the variable itself is significant with a positive sign.

Five predetermined variables are correlated with $\hat{u}_6$. Of the five, per capita pork storage seems the most reasonable to affect the price of hogs. A large quantity of pork in storage at the beginning of a quarter would be expected to decrease the price of hogs. But when this variable is included in the equation, its coefficient has a positive sign and the marketing margin coefficient becomes insignificant.

There is a fairly strong negative correlation between marketing margins and per capita cold storage holdings of pork. Thus with other factors held constant, when storage increases, margins decrease, and when margins decrease, hog prices increase. By this indirect route, an increase in cold storage holdings of pork may raise the price of hogs.

The five equations that were refitted using additional variables are presented below. In each case the additional variable is significantly different from zero and serial correlation in the residuals is reduced.

(2a) $$H=15{,}188.994+\underset{(.154)}{3.127}F_{t-2}-\underset{(433.451)}{8905.125}D_{(3)}$$
$$+\underset{(17.486)}{24.212}T-\underset{(77.757)}{243.264}P_{H_{t-1}}$$
$$R^2=0.941$$
$$d=1.792^{\Delta}$$

(3a) $$Q_P=474.592+\underset{(.002)}{0.128}H-\underset{(1.254)}{3.657}R$$
$$-\underset{(36.720)}{81.884}P_{C(4)_{t-1}}$$
$$R^2=0.995$$
$$d=1.526^{*}$$

(4a) $$S=-865.271+\underset{(.023)}{0.238}Q_{P_{t-1}}+\underset{(1.721)}{7.918}P_{P_{t-1}}$$
$$-\underset{(0.312)}{1.456}W_{t-1}+\underset{(.050)}{0.825}S_{t-1}+\underset{(18.318)}{80.655}D_{(3)}$$
$$R^2=0.937$$
$$d=1.718^{\Delta}$$

(5a) $$P_P=73.489-\underset{(.133)}{1.068}\frac{Q_P}{N}-\underset{(.437)}{1.875}\frac{S}{N}$$
$$-\underset{(.160)}{0.332}\frac{Q_B}{N}-\underset{(.355)}{0.460}\frac{Q_R}{N}+\underset{(.015)}{0.003}\frac{I}{N}$$
$$-\underset{(1.073)}{4.193}D_{55}-\underset{(.010)}{0.025}W+\underset{(.151)}{0.658}P_{H_{t-1}}$$
$$R^2=0.918$$
$$d=1.831^{*}$$

(6a) $$P_H=-14.826+\underset{(.024)}{0.621}P_P-\underset{(.012)}{0.008}M$$
$$-\underset{(.003)}{0.015}W+\underset{(.110)}{0.512}\frac{S}{N}$$
$$R^2=0.965$$
$$d=1.498^{*}$$

$^{\Delta}$No serial correlation in residuals.
*Inconclusive test for serial correlation in residuals.

Of the six equations (including equation (1), which was not refitted), the Durbin-Watson test shows no serial correlation for three equations and for the other three the d statistic is at the upper end of the inconclusive range. The fit for the system as a whole is quite good. The coefficient of multiple determination (R^2) is above 0.90 for each equation.

Evaluation of the Revised Model

In an attempt to resolve the indeterminancy of the Durbin-Watson test, another test for serial

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correlation was tried. The von Neumann-Hart (*16*, *10*) test is designed to test for autocorrelation in an observed sequence of random variables. When it is applied to residuals of fitted relations, it accepts the independence hypothesis too frequently. It does not take account of the added correlation of the estimated residuals resulting from the necessity of estimating the regression coefficients; this defect becomes worse as the number of independent variables increases. However, Hildreth and Lu (*11*) applied this test to the residuals of a number of least squares equations with good results.

The von Neumann-Hart test is based on the ratio of the mean square successive difference to the variance. The ratio is:

$$\frac{\delta^2}{s^2}=\frac{\frac{\sum_{t=2}^{N}(\hat{u}_t-\hat{u}_{t-1})^2}{N-1}}{\frac{\sum_{t=1}^{N}(\hat{u}_t-\bar{u})^2}{N}}$$

The relation to the Durbin-Watson statistic, d, is readily apparent where

$$d=\frac{\sum_{t=2}^{N}(\hat{u}_t-\hat{u}_{t-1})^2}{\sum_{t=1}^{N}\hat{u}_t^2}$$

The mean of least squares residuals is zero so that

$$\frac{\delta^2}{s^2}=\frac{N}{N-1}\,d.$$

The two test statistics for each equation are given in table 1.

TABLE 1.—*Tests for autocorrelation in residuals*

Equation No.	Durbin-Watson statistic	von Neumann-Hart statistic
(1)	1. 840△	1. 883△
(2a)	1. 792△	1. 834△
(3a)	1. 526*	1. 561△
(4a)	1. 718△	1. 758△
(5a)	1. 831*	1. 874△
(6a)	1. 498*	1. 533△

△The hypothesis of zero autocorrelation is not rejected at the 5-percent level.
*The test value falls within the indeterminate range.

The von Neumann-Hart test shows that in no equation is the independence hypothesis rejected at the 5 percent level. The value of $\frac{\delta^2}{s^2}$ for each equation is considerably above the critical value of 1.455 for a two-tailed test at this significance level. This test indicates that there is only a remote possibility of serial correlation in the residuals.

The inaccuracy of this test when applied to the residuals of a regression equation containing a large number of independent variables is shown by the results for equation (5a). Although this equation has a comparatively high d value, it contains eight independent variables so the Durbin-Watson statistic falls within the indeterminate range. The von Neumann-Hart statistic, on the other hand, gives the same significance level for equation (5a) as for equation (1). The latter shows no serial correlation by the Durbin-Watson test. The residuals of equation (5a) may be serially independent but not to the same level of significance as those for equation (1).

The three equations in which the Durbin-Watson test is inconclusive do not contain lagged dependent variables, and each has at least 35 degrees of freedom. The procedure presented by Durbin and Watson (*3*) for use when their test is inclusive is therefore appropriate. The approximate critical values of Fisher's z for 5 and 1 percent tests against positive serial correlation were computed for each of the three equations. These values and the observed value of z for each equation are presented in table 2. When the critical value is less than the observed value, there is significant serial correlation.

The observed value of z is greater than the 5 percent critical value for equations (3a) and (6a) so the residuals of these two equations are serially correlated at accepted significance levels. The residuals for equation (5a) show no significant correlation by this test.

The correlation matrix of the residuals of the refitted equations was computed to give an approximation to the covariance matrix. The matrix for the residuals of the six equations still showed no significant correlation at the 5 percent level, hence the covariance matrix is still diagonal by this approximate test.

TABLE 2.—*Test for autocorrelation in residuals when d is inconclusive*

Equation No.	Critical value of z		Observed value of z
	5 percent	1 percent	
3a	0. 2613	0. 3712	0. 2992
5a	. 4167	. 5954	. 3924
6a	. 2461	. 3495	. 3183

This recursive model adequately explains the variation in six major variables in the hog industry. The coefficient of multiple determination (R^2) is above 0.90 for each aquation. Of the 30 regression coefficients, only 7 are not significantly different from zero at the 5 percent level. The assumptions made about the disturbances are comparatively well met. An examination of the residuals shows only two cases of significant serial correlation as measured by the available tests. The residuals for each equation are uncorrelated with those from other equations.

Summary

A recursive system as described by Wold has many desirable properties. As it is fitted by least squares, the computation is relatively simple. And provided certain assumptions are met concerning the covariance matrix of the residuals, it produces maximum likelihood estimates of the parameters.

The hog production process has been used many times as an example of a cobweb phenomenon. In a cobweb model, price in one period affects production in the succeeding period which in turn affects price, and so on. The link by link progression of price-quantity-price-quantity marks the hog industry as suitable for analysis by a recursive system of equations. If there were considerable interaction between price and quantity within a given period a simultaneous equation system would be preferable. To minimize this interaction, quarterly data were used in fitting the equations.

The price-quantity relation given in the cobweb is an extremely simplified model of hog production. There are many factors that affect variation in the quantity of pork produced and the price received for it. The number of sows farrowing, the pigs raised per sow, the number of hogs slaughtered and their average weight all affect the quantity of pork produced. Storage holdings of pork and pork production affect the price of pork, and this in turn affects the price of hogs, which affects the number of sows farrowing in following periods. All these variables within the hog industry are influenced by numerous factors outside the industry such as the prices and supplies of raw materials (feed grains) and competing goods (beef, poultry).

In order to measure the effects of these variables, a recursive system of six equations was fitted by least squares. The dependent variables in these equations were: (1) The number of sows farrowing; (2) number of hogs slaughtered; (3) quantity of pork produced; (4) cold storage holdings of pork; (5) retail price of pork; and (6) farm price of hogs.

The residuals of these six equations were tested to determine whether they fulfilled the assumptions made about the disturbances in formulating the model. In an attempt to reduce serial correlation in the residuals, five of the equations were refitted using additional independent variables.

The final set of equations furnish a creditable model for describing the hog economy, judging by the variation explained and the significance of coefficients. According to the available tests, the residuals meet most of the requirements necessary for maximum likelihood estimates. There is little evidence of serial correlation in the residuals and no evidence of correlation between residuals of different equations.

With the correct selection of commodities and time intervals, recursive systems fitted by least squares are appropriate. The results of this study indicate that an adequate analysis of the hog industry can be made by using a quarterly recursive model.

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Normative Supply Functions by Linear Programming Procedures

By Ronald D. Krenz, Ross V. Baumann, and Earl O. Heady

In many analyses of profit maximization, attention is directed to large herds and specialization in milk production. Why then do some farmers persist in keeping small dairy herds even when prices for Grade B milk become quite low? This article shows that even with relatively low prices for milk the inclusion of the small dairy herd in the combination of enterprises may still provide the maximum profit from the resources available on the farm. At higher levels of milk prices, it becomes profitable to increase the number of cows and the consequent quantity of milk produced. The various levels of prices and corresponding production of milk constitute a supply function for the farm. This paper illustrates the supply function by utilizing the resources found on a typical 160-acre farm in northeastern Iowa with the full-time labor of two men and $10,250 in capital available. With the aid of variable-price programming, optimum combinations of enterprises for maximizing profits were computed, starting with milk prices so low (92 cents per hundredweight for grade B milk) that no milk cows would be included in the organization. With the price of milk increased to $1.01, a 13-cow herd would maximize profits while the small poultry enterprise would be dropped. With the price of milk at $2.38, a 24-cow herd would be the most profitable and the fall pig enterprise would be dropped. Thus at each level of milk prices, the farmer would have an optimum organization of cows, hogs, and poultry for profit maximization. **This is Journal Paper No. J-3443 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1277.**

Variations in the basic methods of linear programming have been developed recently that extend its usefulness in handling analysis in which such things as resources, factor costs, and product prices vary.[1] Application of the new analytical tools is greatly advanced by the use of electronic computers, which reduce both time and cost of computations.

The purpose and procedures of variable-price programming is the subject of this article. In a variable-price programming analysis for a given resource situation and a particular product, prices for which production plans for the farm should change to maximize net farm income are computed. Thus the scale of prices revealed by the analysis constitutes a normative supply function. The procedures for estimating normative supply functions are illustrated by data taken from the results of a study on the opportunities for making adjustments on dairy farms in northeastern Iowa.[2]

Variable-price programming derives a supply function that can be formalized as follows: $q_A = f(P_1,P_2,P_a, \ldots P_n,R_1,R_2 \ldots R_n,C_1,C_2 \ldots C_n)$ in which q_A=quantity of A produced (P_A varied)
P_1 to P_n=prices of factors and products at the farm level
R_1 to R_n=the fixed resources of the farm (firm)
C_1 to C_n=coefficients of production on the farm in all production alternatives considered.

The quantity of product A produced is not considered as simply a function of the price of product A. The supply function also considers alternative products that may be produced with the given resources, at specified prices for the factors, and the technology of the farm under consideration. The optimum farm production plans derived for each price level are subject to the restrictions imposed and the alternatives offered. Any number of alternative products and techniques of production can be considered, with each combination of techniques included giving a different optimum plan.

[1] Cf. Heady, Earl O., and Candler, Wilfred V., *Linear Programming Methods*. Iowa State College Press, Ames, 1958, Ch. 8.

[2] Additional details will appear in a forthcoming bulletin of the Iowa Agricultural Experiment Station which will deal with research on adjustments to meet changes in prices and improve incomes on dairy farms in northeastern Iowa (an application of programming procedures in deriving supply responses and imputed resource values).

The Nature of the Results

The supply function thus obtained is normative in the sense that it indicates what a farmer would plan to produce if he intended to maximize profits. It is not predictive in the sense that it will explain what he actually will produce.

Production plans for optimum allocation of resources from the viewpoint of society could be obtained by including all possible off-farm opportunities, as well as on-farm opportunities for the use of the farm's resources. But if it is known that the farm operator will not consider off-farm use of his own labor or capital or certain on-farm opportunities, these alternatives can be deleted and the result will be a more "realistic" supply function. Thus by including only the alternatives that the farm operator is likely to consider, the resulting supply function becomes, so to speak, "less normative" and "more realistic." The programming procedure still gives a profit-maximizing plan within the given alternatives. To the extent that farmers do not maximize profits within that framework, the results of this technique are never predictive.

Application to a Typical Farm

The typical 160-acre dairy farm in northeastern Iowa includes 116 acres of rotation land and 30 acres of permanent pasture. The plans presented here are based on a labor supply of two full-time men and a capital supply of $10,250 which can be used for annual crop expenses, livestock investments, or annual livestock expenses. The farm machinery for crops is considered to be given and adequate for any of the possible cropping programs offered. Building resources include space for 36 litters of spring pigs, 16 litters of fall pigs, 175 hens, and 35 dairy cows.

The cropping alternatives include three rotations consisting of corn, oats, and meadow, with variations of from 25 to 50 percent of the land in meadow. The soil type and topography of the area require a minimum of 25-percent meadow for sustained crop yields. Two levels of fertilization are also offered as alternatives.

Livestock opportunities include production of whole milk to be sold as grade B milk at a production level of 9,500 pounds per cow; spring pigs with 7.4 pigs weaned per litter, fall pigs with 7.3 pigs weaned per litter; and a small poultry enterprise of average production. The alternative of buying corn was included at a price of $1.35 per bushel.

The plans shown are the ones that maximize income. No other use of the resources would produce this amount of net income under the assumptions. The programming utilizes all available resources as long as net income can be increased. Whether the farmer would choose the particular plan which maximizes net income would depend upon his propensity for income. However, there might be alternative plans which would produce slightly less income, say $200 less, with a great deal less work, say with 10 fewer cows. The operator might decide to utilize the alternative plan rather than do the work of caring for 10 extra cows for the $200 extra income. Frequently, farmers carry on an enterprise even though it is not as profitable as others at the moment, possibly anticipating higher returns at some later time. Dairying is often one of these because cow herds are difficult to establish or to increase quickly.

Effect of Varying the Price of Milk

Table 1 presents the results of varying the milk price from zero to $3.02 per hundredweight with all other prices held constant. In this instance, the price for hogs was fixed at $17.98 per hundredweight. The price of $3.02 for milk was the upper limit for the latest plan developed.

As noted in table 1, income remains the same for at least two plans at some point in the price range. This is the point at which the farm manager can be indifferent between two plans in maximizing profit. In some instances, three or more such alternatives are available (for example, plans 1, 2, and 3 of table 2). However, as the price moves in any direction from this point, only one plan remains optimum. Likewise, when dairy is included in the optimum plan, income for any one plan varies as the price of milk varies.

At $0.93 per hundredweight of milk, dairy begins to compete with crop fertilization for capital resources. At $1.01, the dairy enterprise also draws resources from the poultry enterprise. When 13 cows are included, production of forage is expanded at the expense of corn production. Fertilizer is the most economical way to do this, but it also becomes necessary to change the rotation

TABLE 1.—*Variable milk prices—hog price constant*

Plan No.	Range in milk price per cwt.	Cropping program		Dairy cows	Litters of pigs		Laying hens	Corn purchased	Range in net income
					Spring	Fall			
	Dollars	*Rotation* [1]	*Acres*	*Number*	*Number*	*Number*	*Number*	*Bushels*	*Dollars*
1	0. 00–0. 92	$CCOM_o$	101	0	36	16	175	1, 628	7, 439
		$CCOM_f$	15						
2	. 93–1. 00	$CCOM_o$	116	3	36	16	175	1, 898	7, 440– 7, 457
3	1. 01–1. 38	$CCOM_o$	116	13	36	16	37	2, 396	7, 458– 7, 927
4	1. 39–2. 14	$CCOM_o$	103	[2] 13	36	16	0	2, 280	7, 928– 8, 895
		$CCOM_f$	13						
5	2. 15–2. 37	$CCOM_o$	106	14	36	16	0	2, 437	8, 896– 9, 203
		$CCOMM_f$	10						
6	2. 38–3. 02	$CCOM_o$	30	24	36	5	0	2, 067	9, 204–10, 682
		$CCOMM_f$	86						

[1] In the rotations C=corn, O=oats, M=meadow. Rotation subscripts, $_o$=no fertilizer, $_f$=fertilized.
[2] The increase in dairy cows in this step was fractional and was not recorded when results were rounded to whole numbers.

to provide sufficient forage. A price of $2.38 for milk is required to put dairying on the same profit level as fall pigs. At some price above $3.02, the dairy enterprise would begin to draw resources from spring pigs. Hence, a dairy enterprise selling grade B milk at $2.68 per hundredweight cannot compete with spring pigs at a price of $17.98 per hundredweight for hogs.

With this combination of resources and production alternatives, it appears that production of milk is relatively profitable at a low milk price. This results primarily because alternative uses of labor and forage in such enterprises as beef cattle were not offered. In each of these plans, not all available labor in any period is utilized; thus labor has an opportunity cost of zero. Hence under the assumptions, any use of the farmer's labor which in combination with other unused resources will produce a return above variable costs will add to the income. Therefore, as long as the price is sufficient to satisfy the farm operator, he will milk cows even if whole milk is as low as $1.01 per hundredweight. This is his only opportunity, among those considered, to use his labor and other unused resources. He can earn this much or nothing. As a result, many operators work for very low returns per hour with some enterprises.

If labor were evaluated at $1.50 per hour, the results would be somewhat different than those shown in table 1. Ordinarily, a farmer would not add 3 cows or 13 cows for an income of $1 or $19 or as in the area of $2.15 to $2.38 per hundredweight for milk—10 cows for $308. This paper is not advocating that farmers do this, only pointing out how a farmer might react to obtain more income under the assumptions of the study. The plans do show, however, what a farmer would produce if his sole objective was to maximize profits.

Similar considerations would be applicable to the data in table 2. A farmer would not likely wish to do all the work necessary to keep 14 sows (in place of keeping 3 milk cows) for $50 extra profit.

TABLE 2.—*Variable hog prices—milk price constant*

Plan No.	Range in hog price per cwt.	Cropping program		Dairy cows	Litters of pigs		Laying hens	Corn purchased	Range in net income
					Spring	Fall			
	Dollars	*Rotation* [1]	*Acres*	*Number*	*Number*	*Number*	*Number*	*Bushels*	*Dollars*
1	0.00–12.95	$CCOMM_f$	113	33	0	0	175	0	7,301
		$CCOM_f$	3						
2	12.96	$CCOMM_f$	103	30	14	0	175	0	7,351
		$CCOM_f$	13						
3	12.97–15.10	$CCOMM_f$	90	26	31	0	175	1,257	7,352–8,269
		$CCOM_f$	26						
4	15.11–15.49	$CCOMM_f$	86	25	36	0	60	1,464	8,270–8,491
		$CCOM_f$	30						
5	15.50–17.44	$CCOMM_f$	83	24	36	2	0	1,570	8,492–9,549
		$CCOM_f$	33						
6	17.45–19.26	$CCOMM_f$	86	24	36	5	0	2,067	9,550–10,621
		$CCOM_f$	30						
7	19.27–19.41	$CCOMM_f$	23	22	36	11	0	2,946	10,622–10,724
		$CCOMM_o$	93						
8	19.42–19.52	$COMM_f$	7	21	36	13	0	3,192	10,725–10,800
		$CCOMM_o$	109						

[1] See table 1 for meaning of letters of rotation.

Effects of Varying the Price of Hogs

Table 2 presents the results of varying the price of hogs with all other prices held constant. In this instance, the price of milk is fixed at $2.68 per hundredweight. Plan 3 of table 2 indicates that hog production would increase from zero to 31 litters of spring pigs at a price of $12.97 per hundredweight. The dairy enterprise would decrease by 7 cows, and the cropping program would change to some extent. The hog-corn price ratio here is only 10 to 1.

Plan 5 indicates that the price of hogs must rise to $15.50 before fall hogs will be produced, and then only 2 litters will be included. Higher prices for hogs increase production by very little. Hence, a supply curve concave upward with decreasing elasticity of supply with respect to hog prices is indicated.

Stability of Production

These plans show that under certain conditions relatively large changes in the farm organization and production program need to be made to conform to profit maximization, given a change in the price of one particular product. However, the increase in net income as a result of the change in production may not be substantial. In tables 1 and 2, the ranges of net income given are the result of the variation in price. For example, as shown in table 2, plan 6 has a range of net income of $1,071 owing to a price range of $1.81, or a change in net income of $5.92 for each 1-cent change in the price of hogs. If, for example, plan 6 was held until the price rose to $19.41 (the upper limit of plan 7), the resulting net income would be $10,680, or only $44 under the maximum profit net income of $10,724. This $44 can be obtained only by a considerable change in the cropping rotation, decreasing cow numbers by 2, increasing litters of fall hogs by 6, and purchasing an additional 879 bushels of corn. The farmer may well conclude that $44 is not worth the effort.

Assumption as to Mobility of Resources

In linear programming, it is assumed that capital and other resources can be moved freely from one enterprise to another without any difficulty but only within the combinations specified by the production plans. Outside this framework of resources and assumptions, the resources are quite fixed. This is a condition that may be completely true only in the long run. For example, it might be fairly easy to reduce the size of a dairy enterprise by selling some cows, but adding cows of the same type might be difficult. A dairyman might prefer not to buy stock because of uncertainty as to disease or other problems, and it would take a number of years to raise the additional cows.

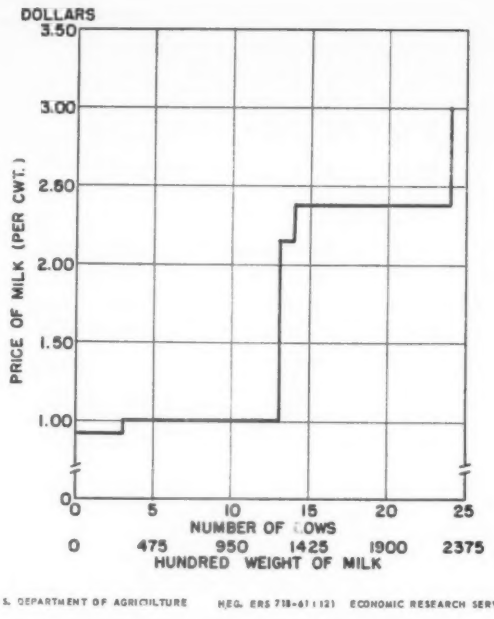

FIGURE 1.—Supply function for milk.

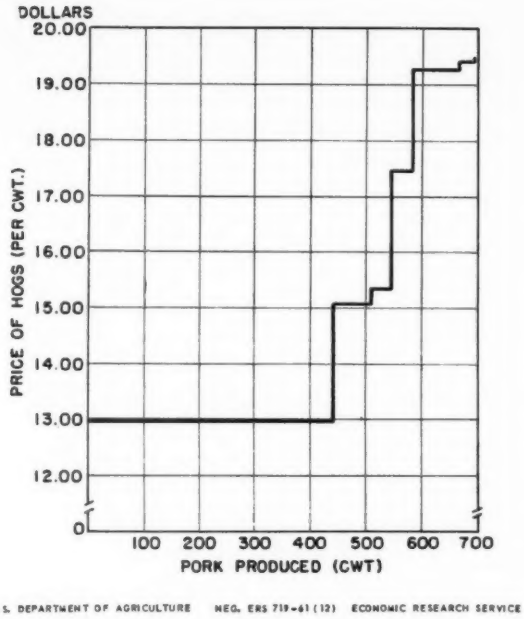

FIGURE 2.—Supply function for pork.

Thus the plans developed here would apply to a situation in which the prices are those expected to hold over a period of time—long enough to permit the adjustments to take place. For short-run price variations, farmers may make simple adaptation such as changing feed rations or levels of feeding.

Graphic Presentation

Figures 1 and 2 present the results in graphic form. The resulting supply curves are of a "stair-step" nature. The stairstep characteristic results from a finite number of alternatives, and rigid resource restrictions used in the programming calculations. The number of "steps and corners" is a function of the number of alternatives and restricting resources.

Although a finite number of major production alternatives is available to any one farmer, different activities can be represented through variations in hog or dairy rations, breeds, timing of production, levels of fertilization, equipment arrangements, and so on. Similarly, the resources available could be subdivided into labor available at many different periods, capital available at different periods, or many other schemes to result in many more resource restrictions. Including more activities and more restrictions will give a normative supply function with more and smaller "steps."

However, the nature of supply functions of individual farms is more nearly represented by the type presented here than by a continuous regression function. Ordinarily, farmers change their patterns of production only for fairly large changes in expected prices and then in a discrete manner. Few if any individuals make adjustments in the sense of a continuous function. Such a continuous regression function would typify an aggregate supply situation, as the steps in the individual supply functions would occur at different prices because of differences in resources and coefficients of production. Also, the effect of any individual change would be almost unnoticeable in the typical aggregate supply functions found in agriculture.

Other alternative methods of presenting results for practical use by individual farmers and extension personnel could be used. One possibility is a production possibility curve with linear segments. However, a 2-dimensional diagram allows an analysis of only 2 products and is thus rarely useful in presenting actual programming results.

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Price Maps

A second alternative is the use of price maps for a 2-price variable programming problem. In this instance, by performing a variety of programming calculations using variable milk and hog prices, a map of plans that would cover the whole area of the relevant ranges of both prices would result. Such a map has the advantage of providing price limits for 2 prices for each plan presented, whereas the results presented here give such price ranges in only one price.

It will be noticed that plan 6 of table 1, and plan 6 of table 2 are identical. Thus we have here established the price limits for only one plan in a price map. To get a complete price map within the range of prices considered here would require several times as much calculation. The research worker can only weigh the added cost against the added information. If only one of two prices shows much variation in the real world, the advantage of a price map would be less. Alternatively, if more prices are considered, it might be best to do a price map with the 2 prices that show the greatest variation in practice.

Lease-Financing and Returns to Capital of Food Marketing Firms

By Stephen J. Hiemstra

The changing structure of the food marketing system focuses attention on competitive relationships existing in food industries. Conventional measures of profits, such as profit rates on stockholders' equity and on total assets, often are used to appraise the performance of these industries. This article points out some of the shortcomings of these profit ratios, giving special emphasis to the impact of lease-financing. Many retail chains use leases to finance their long-term capital needs, but few food processors do. When a firm finances its capital by leasing rather than by ownership or mortgage, the firm's net profit and its stockholders' equity each represent a larger percentage of total assets. As leased assets do not appear on the balance sheet, they represent implicit leverage. The following estimates present value of leased assets for a group of large food processing and retailing firms by capitalizing rental obligations. Total assets plus leased assets give total capital supplied by owners, creditors, and lessors. Gross returns to this capital are nearly equivalent for processors and retailers in spite of inequalities in conventional profit ratios. Some implications of this finding are considered.

IN COMPARING relative profitability of resources engaged in different firms or industries, dollar profits must be taken as a ratio of all capital responsible for generating those profits.[1] Both equity and creditor capital must be included, since distribution of income consistent with ownership rights is not the purpose of the comparison. Similarly, returns to both equity and creditor capital must be computed on total capital.

Stockholders' equity represents only one part of the total bundle of resources. Total assets include a greater share of the bundle because they include debtor as well as equity capital. Next in this progression is the addition of assets leased or hired. This final aggregation more nearly approximates the capital upon which profits and interest are accrued than does either stockholders' equity or total assets. The interest component of rental payment and total interest paid must be added to profits before taxes in obtaining gross returns to capital.

[1] "Profits" in this report are defined by the principles of conventional accounting. Profit data were taken from secondary sources, without adjustment.

A profit ratio based on total assets is at a lower level than one computed on stockholders' equity because of the inclusion of debtor with equity capital (fig. 1). Thus, a difference between industries in their proportion of debt to equity capital (debt leverage) will affect their relative profit ratios. Similarly, a difference in proportion of assets leased (lease leverage) will affect profit ratios computed on total capital (total assets plus present value of leased assets).[2]

Long-term debt of the group of large food processors shown in figure 1 remained nearly a fifth of total capitalization between 1948 and 1958 (*7*, p. 98).[3] The group of food retailers had long-term debt of a tenth on total capitalization in 1948, but by 1954 it had increased to a fifth where it remained until 1958 (*7*, p. 92). As a result, debt leverage played no part in the difference between profit ratios of food processors and retailers shown in figure 1 during 1953–58, and it was a counterforce to variance that existed in the previous 5-year period.

The impact of lease leverage will be explored next.

Long-Term Leases

The share owned of the gross value of resources used in their business is much larger among food processors than food retailers. In the 3 years 1956, 1957, and 1958 processing firms paid out only about a fourth as much in rent as they charged off in depreciation (table 1). In contrast, food retailers paid more in rent than they charged in depreciation. Rents on long-term leases also constitute a much larger part of total rent paid by large retailers than by large processors. Most rental payments by food processors are for machinery and equipment; large items in these categories are data processing and automotive equipment rentals.

About three-fourths of a sample of new supermarkets opened each year since 1954 have been under a long-term lease (*5*). "Sell-and-lease-back" or "buy-build-sell-lease" are terms descriptive of the nature of the contracts entered into by many of these firms. The ultimate lessee assumes the initiative in locating and building or buying the property to meet the firm's needs. The lessee typically pays for maintenance, repair, insurance, and taxes. The lease may include parking lot, fixtures, and equipment used in a store. The terms of these leases are designed to relieve the landlord of of managerial and operational responsibilities. However, many traditional landlord-tenant rental contracts remain in the food business.

Alternative Methods of Financing

Lease financing is a close substitute for debt financing. They have many of the same characteristics and are similarly binding. Among characteristics that are similar are the following:

1. The initial term of the lease normally covers the entire cost of the asset plus interest as does a mortgage. For this reason, obligations are similar in magnitude; a lease will probably be shorter than a mortgage.

2. Cancellation is usually impossible before termination of the lease without a heavy penalty. Frequently a purchase option is included in the lease as the only way of breaking it.

3. Rental payments are based on the original cost of the asset and concurrent interest rates, as are mortgages. No subsequent change in rent is possible during the life of the lease based on change in market value of the asset or change in going interest rates.

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[2] The term "lease leverage" in this report will be used analogously to "debt leverage" in referring to the resources engaged in a firm that are financed by leases. As in the case of debt, leases accrue to the equity of a firm the returns above (or below) the cost of a fixed obligation. For any firm or industry:

$$i=p+(p-r_1)D_1/C+(p-r_2)D_2/C,$$

where i=profit rate on stockholders' equity, p=profit rate on total capital (equity, creditor, and leased), r_1=interest rate paid to creditors, D_1=amount of creditor capital, C=total capital, r_2=imputed interest rate paid as rent, and D_2=amount of capital leased. As long as $p>r_1$ and $p>r_2$, $i>p$. D_1/C and D_2/C, functions of debt leverage and lease leverage respectively, serve as weights in measuring magnitude of difference between i and p. Note that in the absence of both debt and lease financing, the second and third terms become zero and $i=p$. (Adapted from Proposition II, Modigliani and Miller (*3*, p. 271.)

[3] Italic numbers in parentheses refer to Literature Cited, page 29.

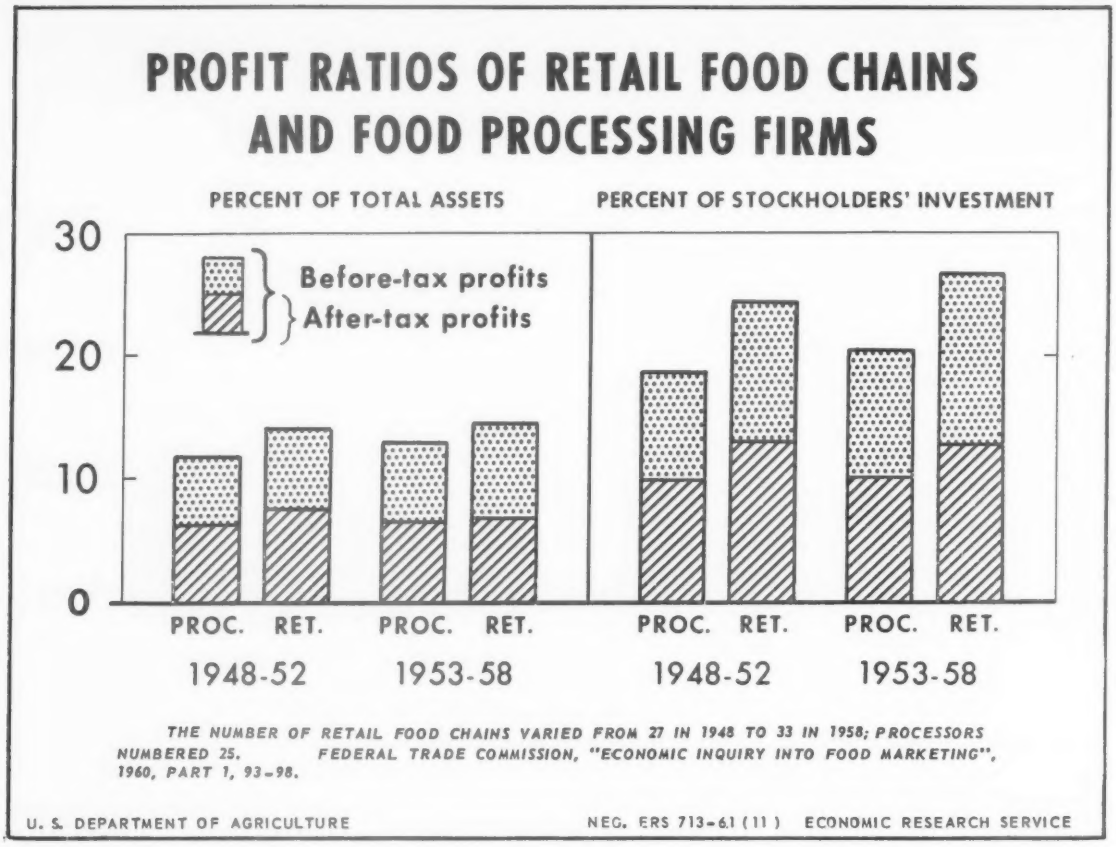
PROFIT RATIOS OF RETAIL FOOD CHAINS AND FOOD PROCESSING FIRMS
PERCENT OF TOTAL ASSETS
PERCENT OF STOCKHOLDERS' INVESTMENT
30
20
10
0
Before-tax profits
After-tax profits
PROC. RET. PROC. RET.
PROC. RET. PROC. RET.
1948-52
1953-58
1948-52
1953-58
THE NUMBER OF RETAIL FOOD CHAINS VARIED FROM 27 IN 1948 TO 33 IN 1958; PROCESSORS NUMBERED 25. FEDERAL TRADE COMMISSION, "ECONOMIC INQUIRY INTO FOOD MARKETING", 1960, PART 1, 93-98.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 713-61 (11) ECONOMIC RESEARCH SERVICE

Figure 1

4. Long-term leases are frequently pure financial arrangements with low operating expenses and managerial requirements, making the investment attractive to large institutional investors (*2*, pp. 123–124).

It is true that in bankruptcy, secured notes and mortgages represent prior claims to lease obligations. But this legal advantage is of small importance if the lease is on property needed to operate a reorganized business. Rent payment may then have greater urgency than other obligations in maintaining continuity of the business.

The result of an incremental switch from debt to lease financing, with no change in the total amount of assets used by a corporation, results in (1) a decline in total assets owned by the firm, (2) a drop in debt outstanding, and, as a result, (3) an "improvement" in several of the conventional measures of financial strength. These measures include a rise in profits computed as a percentage of total assets (assuming no change in dollar profits), a lower ratio of debt to stockholders' equity, and a higher coverage of interest by net income or current assets. When leases are numerous, it is standard accounting practice to recognize them in a footnote to financial statements, sometimes by giving the number in force and their gross value. Usually no attempt is made to clarify the terms of these leases. Thus, an illusion is created in comparing data from financial statements of firms or industries when they differ substantially in the proportion of assets under long-term lease.

Aside from leases, alternative financing includes retention of earnings, sale of corporate stock, notes, debentures or bonds, and accounts payable. Reinvested earnings account for a significant share of the expansion of many industries.

TABLE 1.—*Rent and depreciation paid by food processors and retailers, 3-year averages for years beginning July 1, 1956, 1957, and 1958*

Firm group	Depreciation charged	Total rent paid		Rent payable on long-term leases [1]	
		Amount	As percentage of depreciation	Amount	As percentage of total rent
	Million dollars	*Million dollars*	*Percent*	*Million dollars*	*Percent*
Food processors:					
All corporations [2 3]	720	182	25		
50 large firms	274	93	34	36	39
Food retailers:					
All corporations [2]	249	285	114		
32 large firms	130	180	138	159	89

[1] Primarily minimum annual rent payable at fiscal year end on real property leases expiring more than 3 years from the end of the year.
[2] Corporations reporting balance sheets to Internal Revenue Service.
[3] Total of food and kindred products and beverage groups.

Sources:
All corporations: U.S. Treasury Department, Internal Revenue Service, *Statistics of Income, Corporation Income Tax Returns*, (Washington: Gov't. Print. Off.) 1956–57 pp. 26 and 29, 1957–58 pp. 32 and 35, 1958–59 pp. 33 and 36.
Firms: Compiled from corporate reports prepared for stockholders or the Securities and Exchange Commission.

But without other sources of funds the rapid rate of expansion experienced by the retail food business in the past decade would not have been possible. Equity financing has been used to only a limited extent because management dislikes dilution of ownership. Accounts payable and short-term debt are most applicable to inventory and other rapid turnover capital needs.

It is questionable whether all assets under lease in food retailing could have been financed in any other way without affecting either the growth rate of these firms or the ability to obtain funds on comparable terms.[4] For purposes of analysis and management decision-making, the substitution of debt for leases remains the most feasible alternative. Several large firms rely heavily on long-term leases as a source of capital and have little long-term debt. Two of the nine largest retail food firms in the country have no long-term debt but each has large rental obligations. Clearly, debt could be used to finance a part of the assets currently being leased if these firms adopted this policy.

Other rentals and short-term leases are commonly used in acquiring the use of machinery, equipment, or fixtures. These have the same type of effect on total assets as longer term leases, but their total effect upon the food industry is less. Annual rental payments under short-term leases comprise a larger share of the total value of assets leased than do longer leases.[5] A smaller proportion of assets therefore is not represented in financial statements.

Present Value of Assets Leased

One method of analyzing the influence of leases on the capital structure of a firm or industry is to capitalize its rental obligations. The proper rate to use in capitalizing depends upon: (1) The proportion of original asset cost payable as annual

[4] The effects of alternative financing upon dollar profits is not clear. Profits might have decreased if inefficient, obsolete resources had been used. A rise in costs of borrowing could have resulted from a deterioration of credit ratings based on traditionally-accepted standards of debt ratios. But a slower rate of industry expansion would have increased profits of some firms because of increased pressure of demand upon supply of marketing services and in some areas "overstoring" would now be less of a problem.

[5] A typical equipment leasing plan offered by Nationwide Leasing Company is an initial 3-year lease with 7 1-year renewals. A $25,000 lease requires annual rentals of $9,708 for each of 3 years and $1,250 for the 4th through the 10th years. Annual rental payments exceed one-third the original value of the asset until after total original value of the asset has been recouped (*1*, p. 18).

rental; (2) the average number of years remaining in leases outstanding; and (3) the interest rate that the lessor required when the lease was negotiated. These determinants will vary from one firm or industry to the next, and from time to time, depending upon going rates of interest, type of assets leased, policies regarding lengths of leases, and average age of existing leases.

Gant's evaluation of lease financing uses 10 percent as the basis for capitalization (*2*, pp. 139–40). He contends that 10 percent is conservative as many creditors use 6 to 8 percent, resulting in a higher asset valuation. Capitalizing at 10 percent means that the present value of leased assets is 10 times the amount of the annual rent. It assumes an average remaining length of life of leases to be 15 years with interest at 5.5 percent per annum (table 2). That is, a loan of $1.00 bearing 5.5 percent interest will be repaid in 15 years with annual payments of $0.10. At 4 percent interest, the same annual rent would assume remaining life of leases to be 13 years.

The average length of initial leases was nearly 18 years for a sample of new supermarkets opened between 1955 and 1959 (table 3). In addition, in 1959 renewal clauses were included in 89 percent of the leases. They averaged 2.6 renewal options per lease, and 90 percent were for a period of 5 years. As these data represent a sample of less than 200 stores and are for large stores, they may not be representative of the industry. Detailed data on terms of leases were available for this study on eight retail food chains and four food processing firms. The weighted average remaining length of their real property leases was estimated at 12 years for the retailers and 11 years for the processors.

The appropriate interest rate to assume in capitalizing leases is based on the current market rate of interest if the purpose is to arrive at the current value of leased assets. Any difference existing between the current rate of interest and that existing at the time the lease was negotiated amounts to a windfall profit or loss corresponding to that which would have accrued to the buyer of the asset. The lessee obtains the windfall because the terms of the lease are binding on the lessor, not subject to renegotiation during the life of the lease. The lease corresponds to a 100 percent value loan based on no security other than the property being leased and the "goodwill" of the lessee. So, an interest rate above that yielded by corporate bonds is expected. Moody's "Aaa" corporate bonds yielded an annual average of 3.9 percent and the "Baa's" yielded 4.6 percent between 1956 and 1959 (*6*, p. 103).

Based on 11-year or 12-year average remaining length of leases and a 5.5 percent interest rate, interpolation from table 2 gives annual rent payments between 10 and 12.5 percent of the original value of the assets. These payments correspond to a capitalization rate between 8 and 10 percent. Ten percent is probably conservative in the sense of minimizing the effects of leases. The "true" rate of capitalization to use in evaluating assets leased by food marketing firms is not known.

TABLE 2.—*Capitalization related to annual payment and remaining length of lease under specified interest rates*

Rate of capitalization (percent)	Annual payment	Length of lease remaining if interest rate is—		
		4 percent	5.5 percent	7.0 percent
	Percent of cost	*Years*	*Years*	*Years*
8	12.5	10	11	12
10	10.0	13	15	18
12	8.3	17	20	27

Source: Interest tables, annuity whose present value is one, see Hodgman, C.D., Mathematical Tables, (8th ed., Cleveland: Chemical Rubber Pub. Co., 1947) pp. 316–17.

TABLE 3.—*Percentage of new supermarkets opening with leases of specified length, 1955–59*

Initial term of lease	1955	1956	1957	1958	1959
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
10 years	9	11	19	21	29
15 years	38	42	33	17	28
20 years	25	34	13	29	18
25 years	16	4	17	14	14
30 years	4	3	12	9	5
Other	8	6	6	10	6
All supermarkets in sample	100	100	100	100	100
Average length of lease [1]	*Years* 18.3	*Years* 17.1	*Years* 18.4	*Years* 18.5	*Years* 16.5

[1] Weighted by percentages in each group.

Source: Super Market Institute, Inc., Facts About New Super Markets (Chicago: 500 N. Dearborn, annual issues 1955–59).

Thus, a range will be presented in later tables to indicate a spectrum within which many rates will fall. Reference to table 2 will allow an individual firm to use the rate most applicable to its own operation.

Effects of Leases on Profit Ratios

Large retail food chains and food processors.—Table 4 shows that a group of 32 large retail food chains had less than one-third the value of total assets that comprised a group of 50 large food processing firms in 1956–58. But the retailers paid nearly twice as much in total rental payments and owed more than four times as much rent on long-term leases as did the processors. Rental obligations under long-term leases amounted to nearly nine-tenths of the retailers' rental payments compared with less than four-tenths for the processors. Apparently a much larger share of the long-lived resources in their businesses was leased by the retailers than by processors. Before-tax profits earned by the processors, in aggregate, were more than twice as large as those of retailers. Computed on the basis of total assets, processors earned less by 3 percentage points.

Capitalizing rent payable under long-term leases, and adding it to total assets, increases adjusted assets of retailers by 49 to 74 percent, depending on the rate of capitalization. This rise compares with only 3 to 5 percent for processors. Changing the asset base of the retailers by such a large amount substantially drops their profit ratios when computed on adjusted total assets. After adjustments, before-tax profit ratios of the retailers, at 9 or 10 percent, are less than the processors' 12 percent. The decline in profit ratios is only about one-half of 1 percent for the processors compared with 5 or 6 percent for the retailers. The rate of capitalization used, between 8 and 12 percent, affects adjusted profit ratios to only a limited extent.

If, in addition, rent other than that paid on long-term leases were capitalized, the conclusions reached would be modified but not altered, as a much higher rate of capitalization would be required. Capitalizing at 33⅓ percent, so that a multiplier of 3 is used, results in an additional decline in the profit ratio of 0.1 percent to 0.2 percent for the food chains and 0.2 percent for the processors.

The surprisingly large increase in total assets of food retailers and sharp decline in profit rates that follow rent capitalization dramatize the importance of leasing. Financial statements and their interpretation are greatly altered when leases are evaluated along with conventional sources of capital. Food retailers are not found conservatively financed, as a study of conventional debt ratios would indicate, as they rely heavily on lease leverage. Many food retailers have large fixed rental obligations—this is verified by analyzing footnotes to their published financial statements.

Food processing industries.—Apportioning the processing firms among seven food processing industry groups and comparing each with food retailers does not alter previous conclusions. Substantial variation exists in the profits earned by various processing groups and in the proportion of total rent payable on long-term leases. Three of the seven groups of processors earned higher profits as a percentage of total assets than the retailers earned. But capitalizing long-term rental obligations increased total assets of none of the food processing industries by amounts approaching the retail food chains. Dairy products showed the greatest increase—only 8 percent, using 10-percent rate of capitalization. (The author will supply, on request, the complete results of stratifications by food processing groups and by sales size of firm classes for each of the 3 years analyzed.) The before-tax profit ratio of dairy product firms was reduced by only 1.1 percent by adjusting total assets. The least affected by long-term leases was the meat products group whose profit ratio was depressed by only 0.1 percent by the asset adjustment.

Sizes of firms.—The samples of retail food chains and food processors were each divided into three groups according to size of sales to evaluate differing effects of long-term leasing. The group with the largest sales was somewhat more profitable than the group with the smallest sales in each case. Capitalizing long-term rental commitments lowered profit ratios computed on adjusted assets slightly less in the smallest group than in the largest in each of the two industries. The difference is suggestive of a trend in size but it is not conclusive.

Subtracting data for large firms from all corporation data reported in *Statistics of Income, Corporation Income Tax Returns*, gives a category

TABLE 4.—*Effect of long-term leases on profit ratios of retail food chains and food processors, 3-year averages for years beginning July 1, 1956, 1957, and 1958*

Item	32 large retail food chains			50 large food processors		
Total assets (million dollars)	2, 693. 9			8, 485. 7		
Profits, before tax (million dollars)	408. 5			1, 058. 0		
Profits as percent of assets	15. 2			12. 5		
Total rent paid (million dollars)	179. 6			93. 2		
Long-term rental commitments (million dollars) [1]	159. 4			36. 3		
Percent of total rent	88. 7			39. 0		
	Rate of capitalization					
	8 percent (x 12.5)	10 percent (x 10.0)	12 percent (x 8.3)	8 percent (x 12.5)	10 percent (x 10.0)	12 percent (x 8.3)
Capitalized long-term rent (million dollars)	1, 992. 1	1, 593. 7	1, 327. 5	454. 2	363. 3	302. 7
Adjusted total assets (million dollars) [2]	4, 685. 9	4, 287. 5	4, 021. 4	8, 939. 9	8, 849. 1	8, 788. 4
Profits, before taxes, as percent of adjusted assets	8. 8	9. 6	10. 2	11. 9	12. 0	12. 1
Effect of leases on profit ratios [3]	−6. 4	−5. 6	−5. 0	−0. 6	−0. 5	−0. 4
Percent increase, adjusted assets over total assets	74. 0	59. 2	49. 3	5. 4	4. 3	3. 6

[1] Usually the minimum annual rental commitments at year end payable on real property leases due at least 3 years from fiscal year end.
[2] Total assets plus capitalized long-term rental commitments.
[3] Before-tax profits on total assets minus profits on adjusted assets (decline in percentage points).

Source: Compiled from corporate reports prepared for stockholders or the Securities and Exchange Commission.

of small corporations as a residual. As only total rent payments are given, the proportion payable under long-term leases must be estimated. Also, data from income tax reports are not strictly comparable with data from reports to stockholders and the Securities and Exchange Commission. Profits earned on assets were much less for small than large corporations, both for food retailers and processors; small processors earned more than small retailers. Total rental payments of small retailers were proportionately less than those of large retailers. Capitalization of estimated rental obligations, therefore, increased total assets less, and decline in profit ratios was less—only 1.5 percent in contrast to 5.6 percent. Effects of capitalization on profits of small corporate processors were somewhat less than those of larger firms, and less than these effects on the profits of any size of retailers.

Changes over time.—Between 1956 and 1958, total rent payments increased faster than value of total assets for both large food retailers and large food processors. Rent obligations on long-term leases increased faster than total rental payments, hence both groups exhibited existence of a trend.

Total rent payments were available on six of the large food retailers for 1948, but rent payable on long-term leases was not given. Between 1948 and 1958, these six firms increased total rent payments by more than either total assets or profits before taxes—231 percent for rent payments compared with 157 for total assets and 155 percent for profits before taxes. Even assuming that during this 10-year period long-term lease obligations did not rise as a proportion of total rental payments, leasing grew in importance as total rental payments rose.

Gross Returns to Capital

In table 4 total profits before taxes are computed as a percentage of a large share of capital engaged in the respective groups of firms.[6] However, profits represent the claims of owners of only a part of this total capital, namely the equity of the firm. In order to evaluate total returns to

[6] Besides leased assets, there are other assets used by a firm that are absent from its balance sheet. Any productive service hired for use represents use of resources owned outside of the given firm. Labor services represent an extreme example of the same reasoning.

TABLE 5.—*Gross return to capital of large retail food chains and food processors, 3-year averages for years beginning July 1, 1956, 1957, and 1958*

Item	32 large retail food chains			50 large food processors		
Profits, before tax (million dollars)	408. 5			1, 058. 0		
Interest paid (million dollars)	14. 2			65. 9		
	Rate of capitalization of long-term rent					
	8 percent	10 percent	12 percent	8 percent	10 percent	12 percent
Imputed interest (million dollars):						
On long-term rental commitments [1]	109. 6	87. 7	73. 0	25. 0	20. 0	16. 6
On remaining rent paid [2]	3. 3	3. 3	3. 3	9. 5	9. 5	9. 5
Gross returns (million dollars) [3]	535. 6	513. 7	499. 0	1, 158. 4	1, 153. 4	1, 150. 0
Total capital (million dollars) [4]	4, 746. 7	4, 348. 3	4, 082. 2	9, 113. 4	9, 022. 6	8, 961. 9
Gross return to capital (percent)	11. 3	11. 8	12. 2	12. 7	12. 8	12. 8

[1] Present value of assets under long-term commitments (capitalized long-term rent from table 4) times interest computed at 5.5 percent.
[2] Total rent paid minus long-term rental commitments capitalized at 33⅓ percent times interest at 5.5 percent.
[3] Sum of profits before tax, interest paid, and imputed interest.
[4] Adjusted total assets from table 4 plus excess of total rent paid minus long-term rental commitments capitalized at 33⅓ percent.

Source: Compiled from corporate reports prepared for stockholders or the Securities and Exchange Commission.

total capital, returns accruing to the owners of the balance of the capital must be added to profits.

These other owners are of two kinds—owners of bonds, notes, and other forms of borrowed capital, and the owners of land, buildings, and equipment that is rented. Creditors receive interest as their share of the proceeds of a firm's capital. Owners of rented capital receive rent payments. Rent payments are not analogous to interest but they include an interest component. Rent must be sufficient to cover both a principal payment and interest on the unamortized balance. It is equivalent to purchasing with debtor capital—depreciation (capital consumption) is charged against income as well as interest paid the creditor.

Likewise, profits received by owners of a firm include an interest component for the use of their money. In addition, an equity return based on debt leverage, lease leverage, risk, uncertainty, or monopoly gains may be either added or subtracted. The essential point to note is that all three classes of owners receive either interest alone or an interest component in their returns to capital.

Table 5 contains an estimation of the gross returns to capital of the sample of large retail food chains and food processors. Profits and interest paid were obtained directly from corporate reports. Imputed interest from rental payments was estimated by taking 5.5 percent interest times the present value of assets under lease. Both long- and short-term lease commitments were capitalized so that total rent payments were exhausted.

The striking similarity in gross returns to capital obtained by the two groups of firms contrasts with the ratios presented earlier. Profits on equity alone and on total assets are greater for the retailers than for the processors. When long-term rent is capitalized, profit ratios of retailers drop below those of processors. But now, when returns to all owners of total capital are aggregated, the ratios are nearly equated.

In evaluating the level of gross returns to capital, it must be recognized that two large segments exist: (1) Interest or imputed interest on capital and (2) corporate income taxes. Evaluation of corporate income tax as an economic cost of doing business is outside the scope of this report.

Conclusions and Implications

Lease leverage.—Long-term leases have the effect of reducing the need for long-term debt. They are a means of obtaining the use of assets without increasing the ratio of debt to total capitalization. However, leases do not reduce the proportion

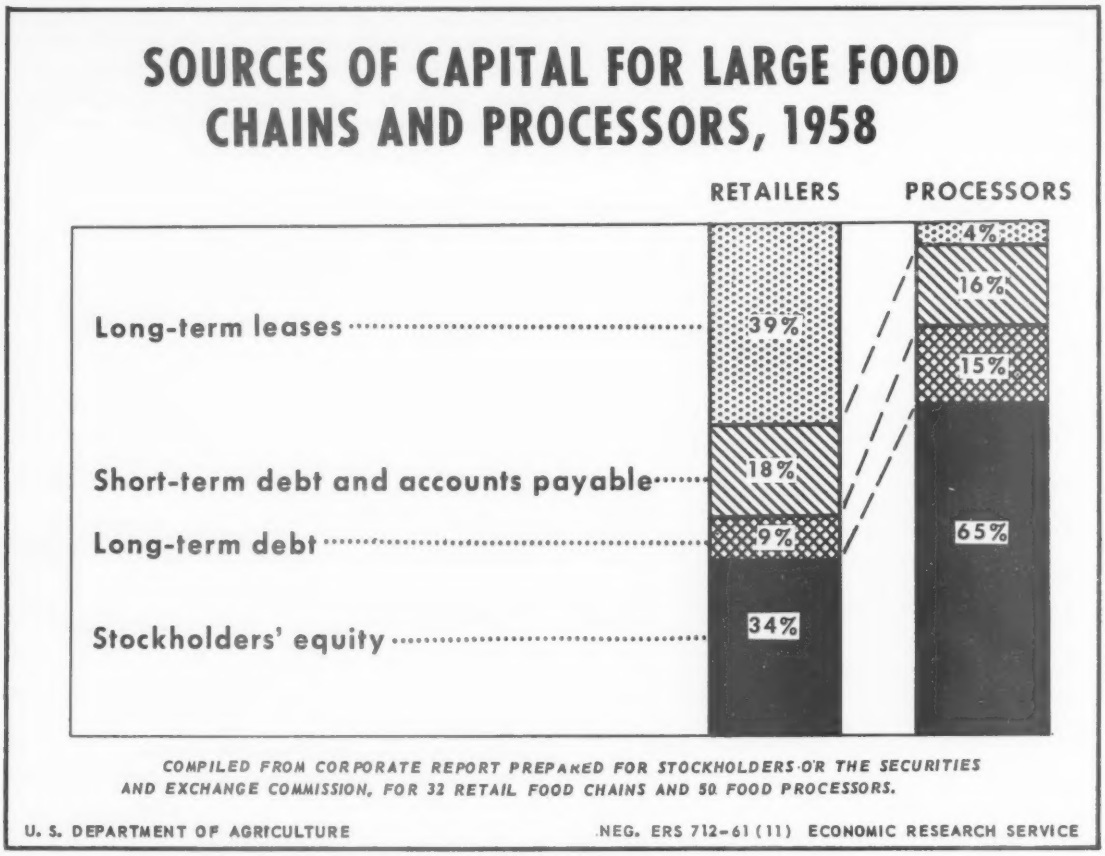

Figure 2.

of total long-term obligations commensurate with the use of a given value of assets. Figure 2 shows the effect upon sources of capital of the large retail food chains and food processors when the present value of long-term leases is included with the components of total assets. Stockholders' equity as a percentage of capitalization is nearly the same in the two groups of firms, but stockholders' equity is a much smaller part of total capital used by retailers.

Equality of gross returns.—The differences in profit ratios shown in figure 1 are explained by figure 3. Profits as a percentage of adjusted total assets are lower for retailers than for processors. But, when interest paid and imputed interest paid as rent are added to profits and the resulting gross returns computed on adjusted total assets, the two sets of ratios are nearly the same. Some variation exists—this depends on the rate of capitalization used—but the conclusion is not altered.

The similarity in gross returns and dissimilarity in other ratios is explicable in terms of leverage. Profits computed on the basis of stockholders' equity alone result in the greatest difference in profit ratios between the two groups, as one would expect from figure 2. Profits accruing to total capital used by the firm over and above the cost of hiring creditor capital, including rental payments, are credited to stockholders' equity. Thus, when equity capital represents a small share of the total, the percentage of profit is correspondingly large, assuming gross returns to capital exceeds the rate received by creditors. On the contrary, if returns to total capital fail to cover the rate of creditors' claims, profits on stockholders' equity will be correspondingly low or nonexistent.

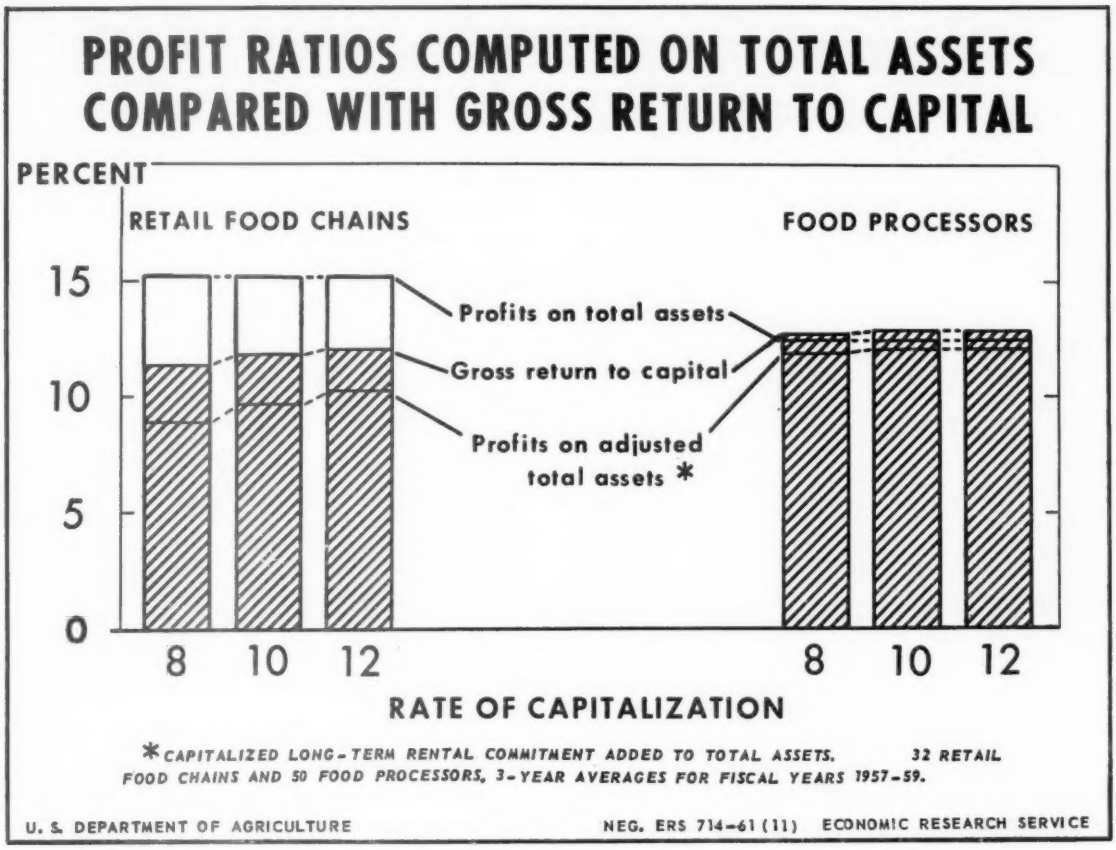

Figure 3.

Likewise, the difference between groups of firms in profits computed as a percentage of total assets is explained by leverage. Total assets represent only a part of the total capital used in a firm. Total assets of the large retailers represented only 61 percent of the total capital (total assets plus leased capital) compared with 96 percent for the large processors (fig. 2). The remaining leverage was exerted by lease financing. Thus, a profit ratio computed on total assets was higher for the retailers than the processors. But when an adjustment of total assets was made to include the value of assets under long-term leases, profit ratios of the processors exceeded those of the retailers. Each of the three sets of ratios represents a step toward increasing the asset base on which to compare profits. Each time the base comes closer to representing the total value of assets. However, not until interest is added to profits are gross returns to this total value of assets obtained. This ratio becomes a consistent concept of value upon which to compare returns accruing to capital in the two groups of firms. This comparison establishes the fact that capital in the two industries—at least that being used by the large firms—is accruing returns that are nearly equivalent.

Nature of competition.—The conclusion that gross returns accruing to capital are similar in large food retailing firms and large food processing firms is consistent with the performance of a free capital market. Resources freely flowing to the industry with the greater potential returns on new investments will yield equal average industry returns if certain conditions are met. These con-

ditions include reinvestment of at least some capital in both industries, declining marginal returns in each industry, revaluation of existing capital in line with price level changes, and schedules of depreciation reflecting true rates of obsolescence and loss of value due to use. It is not known how closely some of these conditions are met by food marketing firms. Thus, equality of gross returns is a necessary but not sufficient condition for establishing the existence of a free capital market and "perfect" competition in food marketing.

Vertical integration.—Mueller and Garoian reported from a study of data from the Federal Trade Commission that all products manufactured by retail food chains and sold through their own stores accounted for 8 percent of total grocery store sales in 1958 (*4*, pp. 72–77). This percentage represented a small decline from the 11 percent of chain-manufactured products sold through chains in 1929–32. The absolute amount of vertically integrated processing activities increased during this period but the rate of increase failed to match the rate of expansion of total grocery store sales. As a result, there was no increase in market concentration attributable to vertical integration by retail food chains over this period.

Vertical integration represents an avenue by which capital funds can flow from the food retailing industry into the food processing industry, or vice versa. It is expected that, by this method, profitable opportunities for investment in either industry would attract funds from the other, assuming the nature of the scale economies of each industry and institutional restrictions permit it. Complementary production coefficients, reduced transaction and informational costs, and management's ability are greater in vertically allied industries than in unrelated industries, hence investments outside a given industry often tend to be vertically directed into profitable alternatives. Other factors including desirability of establishing dependable supply sources for uniform quality products or captive outlets for products of a firm are also powerful forces stimulating vertical integration. However, the profit motive as an important incentive fostering vertical integration is advanced, among other writers, by Mueller and Garoian (*4*, pp. 81–88).

The fact that no relative increase in vertical integration of grocery chains has occurred in three decades is consistent with the findings of this report. Profitability of food processing is about the same as that of food retailing. Because this is the case, no profit motive exists to foster vertical integration by either industry. This conclusion is based on industrywide data—exceptions may be found within the food processing industry. In fact, vertical integration has been limited largely to particular food groups, where it is quite important, thus obscuring the overall conclusion.

Limitations of Study

Critical assumptions must be made at certain points in capitalizing rental commitments to obtain present value of leased assets, in estimating imputed interest from rental payments, and in defining total capital and gross returns to capital. A range in rates of capitalization and details of estimates are given to strengthen validity of the conclusions. Nevertheless, intricacies of capital financing and the following limitations of the study augur for caution in generalizing from the conclusions.

1. The evidence is presented in terms of large retailers as a group versus large processors. Data on small firms in either group is sketchy.

2. An equality of returns to capital used by the two groups does not preclude the possibility that both groups of firms include elements of imperfect competition to an approximately equal degree. No comparison of returns was made with either nonfood industries or a competitive norm.

3. Only one criterion of the nature of competition is analyzed, namely, returns to capital. But economic theory attaches great importance to this one element of market performance.

4. The analysis is based on data from accounting records of firms. Additional measurement problems and departure from theoretical concepts regarding such items as wages to management, depreciation, and valuation of assets may alter the results.

5. The time period of 3 years is relatively short for drawing long-term conclusions.

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Productivity and Food Processing Costs

By William H. Waldorf

Measures of productivity, for agriculture as well as for the private sector of the economy as a whole, have a long and fruitful history in helping to interpret movements in output, prices, and factor costs. To an economist who is familiar with productivity research, and who has watched the continuing rise in marketing charges for farm products, the inevitable question is: What can measures of productivity tell us about the continued rise in the Farm-Food Marketing Bill and the Farm-Food Market Basket (farm-retail spread)?[1] This paper is only a step in that direction (*1*)[2]—it presents some new information, and it brings together our major findings on productivity in factories that process farm food products (*10*). (Similar work on distribution of farm foods is now underway.) Within the last decade, food processing costs in factories have accounted for roughly a third of the Farm-Food Marketing Bill. The eventual product of this area of research should advance our knowledge of supply relations for marketing services for food and, therefore, better our understanding of the relationship between consumer demand for food at retail level and the marketing system's derived demand for agricultural products at the farm level. Briefly summarized, the principal finding in this paper is that, during the post-World War II period, food manufacturing *as a whole* was an average sector with regard to total productivity and price increases—the postwar rise in the price of food processing services was part of the general price rise in the economy as a whole. **The author expresses his appreciation to Jerome Mark, Frank deLeeuw, William Wesson, Forrest Scott, and Allen Paul for their helpful comments.**

THE MOST commonly used measure of productivity is output per man-hour—that is, "real" output divided by number of man-hours. Changes in output per man-hour reflect substitution between labor, capital, and other production inputs. They also reflect changes in the quality of these productive inputs, technological changes within the industry, and changes in efficiency resulting from economies of scale. Without laboring the point, we can see that output per man-hour is not comprehensive enough to measure changes in technology or efficiency of resources employed in a particular sector. Nevertheless, indexes of output per man-hour are useful. They supplement data on changes in average hourly earnings. When consistently defined, output per man-hour relates average hourly earnings of employees to unit labor costs in production.

A second measure of productivity is output per unit of capital—that is, output divided by some measure of capital inputs.[3] Output per unit of capital inputs obviously suffers from at least the same shortcomings as output per man-hour for measuring changes in technology or efficiency of resources employed in a particular sector. Analogous to the output per man-hour series, output per unit of capital relates returns to capital inputs to unit capital costs in production.

During the last decade, the "total productivity" index has come to the fore. Essentially, it involves dividing an index of net output by an index constructed from a weighted sum of man-hours and capital inputs. Like output per man-hour, total productivity can be a useful descriptive measure.[4]

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[1] As defined by the Economic Research Service, the Farm-Food Marketing Bill is the difference between civilian expenditures for farm foods and the farm value of the raw products. The Farm-Food Market Basket is defined as the difference between the retail cost of the "market basket" and the farm value of the "market basket."

[2] Italic numbers in parenthesis refer to Literature Cited, page 34.

[3] The reciprocal—the "capital-output ratio"—is more generally used (*4*).

[4] If labor accounts for a large share of combined labor and capital inputs and there has been little or no substitution between labor and capital, output per man-hour can be used to approximate long-term rates of growth of output per unit of labor and capital combined. This has apparently been the case in food manufacturing: From 1919 to 1957, output per man-hour increased 2.3 percent a year compared with 2.1 for output per unit of labor and capital combined. The approximation gets increasingly worse as we shorten the time period.

In order to have stable prices, compensation to labor and capital combined must increase in proportion to total productivity (if the series are consistently defined). That is, if a combined increase in average hourly compensation of labor and returns to capital in food manufacturing exceeds an increase in total productivity in the industry, the price of food processing services will rise. This is a truism obtained from national income accounting.

Total productivity indexes have also come under attack.[5] The major limitation of these indexes results from poor data on inputs, particularly capital inputs. In brief, available measures of factor inputs are not comprehensive enough; for example, the data on capital inputs can, at best, only "allow" for *some* substitution between labor and capital inputs. Total productivity measures, nevertheless, indicate trends and can provide some useful insights for policy—at least by default. They indicate that from the point of view of measuring efficiency of resource use, what we can not measure must be more important than what we can measure.

Technically speaking, the total productivity index can be thought of as derived from a linear production function.[6] What total productivity is really supposed to measure is shifts in the production function—that is, technological changes *within* the industry. What in fact it does reflect is technological changes within the industry, unmeasured changes in quality of both labor and capital inputs, economies of scale, shifts in production between commodities and firms with different levels of productivity, changes in efficiency of resource allocation because of changes in competitive structure of the industry, and so on. Each one of these may involve essentially different policy considerations.

Output and Prices of Processing Services

In order to apply the productivity framework or do any macroeconomic analysis of food processing, it is necessary to measure both the "output" and the "price" of total processing services. Our estimates indicate that output in factories processing farm food products rose 32 percent from 1947–49 to 1959, the most recent year for which data are available (table 1). Part of this rise reflects increased consumption of farm foods, but a significant part reflects more factory processing of these products (*11*, pp. 5–7). The price of these food processing services rose 33 percent. During the same period, the general price level for the economy as a whole rose 30 percent, as measured by the implicit price deflator for gross national product. This means that the "real" or deflated price of factory processing services—the price of processing services divided by the general price index—remained about the same between 1947–49 and 1959 while output rose 2½ percent a year. By comparison, the "real" price of processing services for food remained unchanged between 1929 and 1939, but output rose only 1 percent a year.[7]

TABLE 1.—*Output and price of factory processing services for farm food products, selected years, 1929–59*

[1929=100]

Year	Output [1]	Price [2]	"Real" price [3]
1929	100	100	100
1937	105	83	97
1947–49 average	154	153	102
1953	173	181	105
1957	191	199	105
1959	203	204	104

[1] Measures output of manufacturing establishments processing domestically produced farm food products. Output excludes processing of fluid milk, cream, and eggs; it includes food byproducts.

[2] Index of "value added" for manufacturing establishments included in output (column 1) estimated mainly from data reported in Censuses of Manufactures divided by the net output index (column 1).

[3] Index of price of factory processing services (column 2) divided by implicit price deflator for gross national product published by U.S. Dept. Commerce.

[5] For an appraisal of concepts and data used in productivity analysis, see *Output, Input and Productivity Measurement* (*2*).

[6] Instead of an arithmetic aggregate for inputs assuming a linear production function, we could use geometric indexes which would hypothesize a Cobb-Douglas production function; see Zvi Griliches (*6*).

[7] A scatter diagram of "real" prices and output including data for intermittent years indicates that "stable" real prices was the general pattern (that is, there was no upward or downward trend) during the two subperiods, 1929–39 and 1947–59.

We can, therefore, conclude that after "adjusting" for the inflation in the economy as a whole, the postwar rise in the cost of processing farm foods—that is, the rise in "real" costs—was due to an increase in the volume of processing services, not to a rise in the "real" price of these services. Stated another way, inflation in the economy generally, and an increased volume of processing services, accounted for the postwar rise in factory processing costs.

A few definitions are undoubtedly in order at this point. Our measure of output of factory processing services is, *roughly speaking*, "value added" adjusted for changes in prices.[8] "Value added" is essentially the difference between value of industry shipments and costs of materials and supplies as reported in the Census of Manufactures. The "price" of factory processing services is an "implicit" price obtained by dividing the series on value added in current dollars by the series on net output. The obvious statistical pitfall with regard to this indirect method of computing the price series is that both errors of measurement and biases in the output and price series are inversely correlated. Among other things, the output series does not fully reflect quality changes. Hence, it probably understates the increase in output of processing services; consequently, the implicit price series probably overstates the rise in the price of these services. That is, the "real" price of factory processing services may have actually declined over the postwar period 1947 to 1959. Unfortunately, I know of no better way of estimating a series for price of processing services.

Productivity in Food Manufacturing

Changes in the price of processing services can be divided into changes in total productivity and changes in factor prices. Turning now to our measures of productivity in food manufacturing, almost all of the following discussion will be in terms of total productivity—that is, output per unit of labor and capital combined. Data are not available on capital inputs in factory processing of farm food products only. We shall have to base our analysis of total productivity on food manufacturing—that is, Food and kindred products (excluding Beverages). This should serve our purpose because processing of farm food products accounts for about 85 percent of total food manufacturing.

[8] The major statistical pitfalls of the output index for purposes of this paper are (1) because of lack of data, the formulas used only approximate the net output concept, and (2) like all physical output indexes, it does not fully reflect changes in quality of production; see Waldorf, (*11*, pp. 27–39).

TABLE 2.—*Total productivity in Food and kindred (excluding Beverages) manufactures, United States, selected years 1929–59*

[1929=100]

Year	Output [1]	Labor-capital inputs [2]	Total productivity [3]
1929	100	100	100
1937	104	91	114
1948	161	104	155
1953	180	104	174
1957	200	109	183
1959 preliminary	212	112	189

[1] Based on Federal Reserve Board Index of Industrial Production for food manufactures after 1948.

[2] Based on the stock of total capital (fixed plus working capital) estimated by Daniel Creamer (*3*, *4*) and total number of man-hours worked by *all* employees, estimated mainly from employment and hours data reported in the Censuses and Annual Surveys of Manufactures. Index of inputs computed from a cross-weighted index number formula using weights for 1929 and 1957.

[3] Output divided by labor-capital input index. Computations for total productivity are based on unrounded figures.

Inputs of total man-hours plus total capital employed in food manufacturing rose 8 percent from 1948 to 1959 (table 2), the latest year for which capital data are available. Thus, if there had been no increase in total productivity, output would have increased only 9 percent. Output actually rose 32 percent, which means that total productivity—output divided by inputs of labor and capital combined—rose about 22 percent or about 1.8 percent a year. Roughly three-fourths of the total rise in output resulted from increased productivity; only a fourth came from counted inputs of labor and capital.

A word on our measures of inputs should be mentioned at this point (*10*). Labor inputs are measured by total number of man-hours *worked* by production and nonproduction workers. Capital inputs are based on Creamer's data on the stock of total capital—that is, fixed plus working capital (*3*, *4*). Changes in the stock of total capital and in the man-hour series do not reflect changes in the quality (including new technology) of these

factor inputs. There is also the difficult accounting problem in measuring depreciation of capital goods realistically. To these statistical and accounting problems must be added the critical assumptions that the flow of capital services used in production is proportional to the stock of total capital and that the flow of labor services is proportional to the number of man-hours worked. Much of the controversy over the usefulness of the total productivity concept centers on the statistical pitfalls in measuring inputs of capital services.

How does the postwar annual productivity rate of 1.8 percent in food manufacturing compare with the rate before World War II, and with postwar rates in other sectors? The annual rate of growth of total productivity in food manufacturing between 1929 and 1937 was 1.7 percent. Thus, the annual rate of growth of total productivity during the post-World War II period was about the same as the rate during the prewar period marked by the Great Depression. During the three decades 1929–59 as a whole, total productivity in food manufacturing rose about 2.2 percent a year, because the annual rate of growth between 1937 and 1948 was sizable. Comparison with Kendrick's (*7*) estimates indicates that, during the postwar period 1948–57, the annual rate of growth in food manufacturing was about the same as in the private nonfarm sector, but only a little more than half as great as in farming.

If total compensation to labor and capital employed in food processing had increased at the same rate as total productivity in food manufacturing during the postwar years—that is, at 1.8 percent a year—the price of factory processing services for food would have remained constant. Prices of productive inputs, however, rose considerably faster than total productivity and, as a result, the *absolute* price of food processing services rose about a third during the period. But available data on hourly earnings and returns to capital indicate that increases in input prices in food processing generally paralleled increases in the nonfarm sector of the economy.

Several notable trends underlying the postwar growth in total productivity in food processing may be enumerated (*10*):

1. Productivity gains in food manufacturing during the postwar period apparently have been as much fixed-capital saving as labor saving. That is, the amount of fixed capital per unit of output declined at about the same rate as the ratio of total man-hours worked per unit of output.

2. Data on output per man-hour indicate that shifts in production from processing industries with higher levels of output per man-hour to those with lower levels have retarded the rate of growth of output per man-hour in all food processing. This is partly due to differences in capital per worker between industries, but future research will indicate if it is also due to differences in levels of total productivity.

3. There has, of course, been an upgrading in the "quality" of man-hour inputs, but as far as can be seen from the data, increased "quality" of labor inputs within individual industries—that is, shifts from production workers to nonproduction employees—have been offset by interindustry shifts.

Summary and Conclusion

We can now summarize our principal findings following a somewhat different outline. During the postwar years 1947–49 to 1959 increased volume of factory processing services for farm foods accounted for about 45 percent of the total rise in processing costs; higher price of these services accounted for the remaining 55 percent. The higher price of processing services resulted from the fact that compensation to factor inputs rose faster than total productivity. However, the rise in total productivity and increases in input prices in food processing paralleled movements in the nonfarm sector of the economy as a whole; and, consequently, the "real" price of factory processing services remained fairly constant.

By the way of outlook, the average price of factory processing services for farm food products may rise, even relative to an overall price index for the economy as a whole—that is, we may be looking forward to a rise in the real price of factory processing services for foods. Differential increases in consumer demands for different food products have resulted in shifts from production of grain-mill products which have a higher level of output per man-hour to production of meat products, which have a lower level of output per man-hour. This change in the product "mix" has retarded the average rate of growth of output per man-hour for all food processing industries. Judging from time series and consumer

budget studies of income elasticities for foods, this shift will continue for some time (*5*).

The difference in output per man-hour between the grain-mill products and the meat products industries reflects, in part, differences in capital per worker employed in the industries (*4*, p. 68). To the extent that gains in total productivity arise from new technology which processing firms adopt through purchases of new and modernized plant and equipment (*9*), the shift in production from more to less capital-intensive industries could have a dampening effect on total productivity. Also, and perhaps more important, because of the growth in the total capital stock relative to labor, "real" hourly earnings of workers historically have risen relative to "real" returns on capital in the economy as a whole (*8*). If this trend continues—and it probably will—the shift in production from less to more labor-intensive industries will mean a rise in the average "real" costs per unit of factory processing services for all foods.

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Book Reviews

Economic Areas of the United States.

By Donald J. Bogue and Calvin L. Beale. Free Press of Glencoe, New York. 1,162 pages. 1961. $22.50.

MOST of us who use census reports have felt the need to know more about the State Economic Areas and Economic Subregions which, since 1949, have been part of the census reporting system. Now the principal architects of this network have put flesh and bones on the symbols that appear on the column heads. They have done this with crisp prose, well chosen photographs, statistics, and descriptive names for all areas and subareas.

Bogue and Beale support the system of economic areas by tracing the procedures for their derivation. They argue in economic and statistical terms for their enduring quality. They stress the flexibility of a system in which State areas composed of counties can be recombined to form differing regions. In building up their case from a wealth of experience, the authors have prepared an introduction and an appendix that make up a significant contribution to the theory of regional economics, the more so because too many Anglo-American theorists have a "one point world" model. Until quite recently, the main concern has been variation in time, with regional variation left implicit in cost functions.

Bogue is a professor in the Department of Sociology at the University of Chicago, and Beale an analytical statistician with the Economic Research Service of the U.S. Department of Agriculture. Support for their original delineations came from the Bureau of the Census, which, together with the Department of Agriculture, reviewed the results. The present work presents for the first time 5 Economic Provinces and 13 Economic Regions, built up from the basic network of 121 Economic Subregions and 506 State Economic Areas.

The text is a description of physiographic, economic, and outstanding ethnic features of the American landscape. In the first part, each region and each subregion is introduced by population and land area figures, maps, tables, and other data to facilitate cross-reference to the following part in which State economic areas are described. The two parts are well integrated with repetition kept to a minimum. The third part consists of 1950 statistics on population, employment by industry groups, and income by State economic areas, subregions, and regions. Agricultural data are given for 1950 and 1954. Population data for 1960, by urban, rural, metropolitan and nonmetropolitan breakdowns, are given in the introduction. The introduction also contains a collection of maps and a county index to regions, subregions, and State areas.

The authors have succeeded in presenting the most important features and trends. Although other aspects are not neglected, agriculture looms large. This, the authors explain, is not a bias but reflects the diverse nature of farming and its preponderance over many square miles. Most of the statistics and maps were previously published but are scattered over many and diverse census volumes and other sources. Some of the maps attempt to show too much for easy reading. While agreeing that the distinguishing characteristics of most regions are so basic that their boundaries change slowly, it is to be hoped that so valuable a work will be kept current by statistical supplement and by periodic review in light of recent economic and demographic development.

Economic Areas of the United States is a major aid to all who need to know why and how one part of the Nation differs from another. This is one of those too infrequent books that serve both professional and general readers who wish to know the United States.

Karl Gertel

Automatic Data Processing Seminar For Federal Executives.

Edited by B. Ralph Stauber. The Graduate School, United States Department of Agriculture, Washington. 240 pages. 1961. $4.50.

ADP, the initials referring to automatic data processing, is capturing the imagination and attention of a large audience. Numerous books have been written on this subject; no doubt many more await publication. This volume consists of a compilation of papers presented at a seminar conducted by the Graduate School of the U.S. Department of Agriculture in the fall of 1960. Such meetings are designed ". . . to acquaint top Federal Executives with the scope, challenge and capabilities of modern data processing techniques and equipment. . . ." Between its covers, the reader finds 18 papers relating to ADP theories, experiences, pitfalls, and suggestions, all frankly discussed by well-qualified people. These men and women, representatives of organizations in and outside Government circles, were invited to participate because of their varied backgrounds and their experience in this field.

After initially detailing the impact and the role of ADP on Federal agencies, the papers cover a whole spectrum of data processing activity. Topics taken up relate generally to such areas as the evolution of punch-card equipment; tools for originating, communicating, storing, and retrieving data; characteristics of electronic digital computers; programing principles for such machines; the theory and application of automatic coding; systems analysis and design; implementing and operating computing facilities; and, finally, a look at future prospects for information systems from the hardware and management points of view. Because of the nature of this subject and the organization of the project, the reader finds repetition among these papers. But the repetition of facts in this new area is not necessarily a disadvantage. Knowledge of basic principles and the exacting demands of these machines must be stressed continually.

I believe that the compilation of this material furthers the understanding and usefulness of this comparatively new tool. It will certainly serve as an excellent reference for the user of data processing equipment. In addition to securing a general review of most basic ADP principles, the potential user can benefit from the suggestions advanced by these authorities. Most important, however, this volume will be an invaluable guide for those organizations which must yet encounter the early agonies and growing pains associated with the development of a computer facility.

H. Weingarten

The Farmer's Age: Agriculture, 1815–1860.

By Paul Wallace Gates. Holt, Rinehart and Winston, New York. 460 pages. 1960. $6.00.

PROFESSOR GATES presents a comprehensive picture of the economic growth of American agriculture in this sixth volume to be published in the Economic History of the United States series. The period from 1815 through 1860 was one in which the farmer might well have felt that everything was going his way. On the other hand, there were clear signs in 1860 that other economic factors were developing which would have more future influence on the total economy than the American farmer. Covering part of the time span of L. C. Gray's *History of Agriculture in the Southern United States to 1860* and Bidwell and Falconer's *History of Agriculture in the Northern United States, 1620–1860*, Gates has given a concise outline of the agricultural economy. He has made extensive use of writings published since the previous studies were made, thereby broadening the outlook.

The broad field of this study is organized under a combination of geographical, topical, and commodity headings. After briefly discussing farming practices, economic conditions, and the influence of land on the settled area of the South and the North, Gates discusses the public land policy down to the opening of the Civil War and the part the speculator took in opening the land for settlement. He follows this with a discussion of livestock raising, dairying, and the production of major and minor agricultural commodities, including problems of marketing and distribution. In each case, he shows how the area of production was influenced by the crops produced and in turn influenced other areas. The last part of *The Farmer's Age* deals with more general subjects including: labor and farm machinery; interest in the introduction of new or improved crops and livestock; development of State and Federal con-

cern and aid for agriculture; the agricultural press and journalists; agitation for education in scientific agriculture; and land and farm problems of the far West. In the last chapter, Gates summarizes the economic problems that producers faced in their search for land, credit, and markets.

Gates, who is an authority on the history of public land policy, has used his broad knowledge in that field as an undercurrent to bind together this study of an expanding agricultural economy in a period of rapid land settlement and general economic expansion. With his broad yet concise treatment of agriculture in a period of extensive technological changes and expansion, Gates has included a useful annotated bibliography which he has organized by type of reference and by such subjects as: settlement and economic development, land policies and land companies, agricultural machinery, marketing problems, food consumption, role of government, farm labor, agricultural education, and individual agricultural commodities.

This work will be long appreciated by those who wish to consult a concise yet broad study of American agriculture in the period between the War of 1812 and the Civil War.

Vivian Wiser

The Powerful Consumer.

By George Katona. McGraw-Hill Book Company, Inc., New York. 276 pages. 1960. $6.50.

Household Decision-Making.

Edited by Nelson N. Foote. New York University Press, New York. 349 pages. 1961. $6.50.

KATONA'S books on psychological economics and the volumes in the Consumer Behavior Series, of which Foote's is the fourth, are particularly fertile sources of contributions of other social sciences to economic studies.

Katona's book here under review summarizes the contributions of survey research to understanding the influence of consumers on the stability or instability of the American economy. Its generalizations were developed from intensive analysis of data collected for more than a decade by the Survey Research Center of the University of Michigan. The research of that group has been primarily aimed at study of variations in the rate of spending and saving as they influence the entire economy, not at study of fluctuations and variations in consumer purchases of individual goods and services or of products of individual firms.

The two basic propositions of Katona's book and of his research are: "Demand depends on income and confidence" and "Changes in confidence are measurable." Confidence rests on psychological factors, such as motives, attitudes, expectations, and group belonging. These are intervening factors which operate between the stimuli of market conditions and the responses to them in the form of economic decisions.

The development of psychological economics in the United States has been directly related to the increasing latitude for consumer action in spending the incomes of our modern economy. Whereas traditional economics explains changes in consumer demand in terms of incomes and needs, psychological economics adds the role of willingness to buy. This role is especially important for consumer durables in short-run fluctuations and in business cycles.

Katona has found that changes in consumer attitudes provide advance indications of changes in consumer spending on durable goods and make a net contribution to the prediction of such spending after the influence of income is taken into account. Changes in consumer attitudes reflect the influences of economic developments and the knowledge of them on so-called variable attitudes. Both variable and stable attitudes, along with habits and motives, influence how stimuli are perceived by consumers and how consumers react to them.

Modern psychology also contributes to economic analysis the postulate that behavior is multimotivated. This idea contrasts with the postulate of classical economic theory that there is a single comprehensive motive—maximization of utilities or profits.

Whereas traditional economic theory recognizes only a positive motivational force, Katona and his associates assume that both positive and negative motives prevail.

Katona concludes his book on this optimistic note: "The consumers themselves, by understanding what is happening and what they are doing, provide the best hope for a continuous growth of the economy, not interrupted by severe recessions. A better understanding of economic processes by consumers would promote more farsighted beha-

vior and represents therefore an important goal for the near future" (p. 246).

The title of Foote's book indicates the interest of the 1958 conference on Consumer Behavior, Inc., in the behavior of small groups, particularly households. In his introduction, Foote points out that consumption occurs in and through certain units that possess properties of their own. These are changing properties which mediate the relations between antecedents and consequences. In individuals, psychologists describe these intervening variables as motives and attitudes. In households, they become such phenomena as authority, influences, and values.

The papers in this book are arranged so that the contributions of economists, sociologists, and psychologists to decision-making may be compared. Research in five areas of household decision-making is reviewed: Changes in family composition; saving and borrowing; allocation and spending; buying, including brand choices; and husband-wife roles and careers.

The value of the major conference papers is much enhanced by including both some prepared discussion papers and the crossfire of ideas from the conference participants.

For example, H. S. Houthakker presented in "An Economist's Approach to the Study of Spending" a number of ideas with which other economists at the conference agreed and some with which they took issue. In the first category was this statement (p. 127): "The concept of preference ordering . . . is so clearly subjective that it is the relation to the properties of commodities that now tends to be forgotten. For the modern theory of consumer's choice, the actual content of preferences, as distinct from their consistency, is a contingent fact about which nothing is said. . . ."

F. Thomas Justin and others disagreed with this argument of Houthakker: ". . . the most immediate test of the relevance of pure theory is the empirical constancy or stability of the parameters that it introduces. Because the economic theory of consumption puts such great stress on prices and incomes as determining factors, the requirement of constancy applies in particular to price and income elasticities. . . . The best we can hope for is that the parameters applicable to various time periods and communities are not too different from each other" (p. 133).

Justin replied (p. 167): ". . . It seems to me that looking for invariance is like searching for the fountain of youth—not likely to be successful and very likely to direct energy into retrospectively useless channels. What is needed, rather, is to direct attention to the factors that influence the magnitude of elasticities in different circumstances. . . ."

To learn more about psychological economics, read Katona's book. To extend the scope of your knowledge of consumer behavior, the papers and discussions in Foote's book will be worth your time.

Marguerite C. Burk

Adoption of New Ideas and Practices.

By Herbert F. Lionberger. Iowa State University Press, Ames. 164 pages. 1960. $3.50.

YOUNG and inexperienced educators who are concerned with bringing about desirable changes among adults will find that this book has brought together a wealth of sound research materials that can be put to immediate and practical use. Lionberger points out that for most practices, people appear to go through a series of five distinguishable stages: (1) Awareness, (2) interest, (3) evaluation, (4) trial, and (5) adoption. He points out that research shows that the time required for complete adoption of particular farm practices varies from a few months to many years and seldom is 100 percent.

Lionberger points out that many conditions and situations affect the individual's rate of adoption, e.g., source of information, community prestige of the innovator, attitude of prospective adopter, adopter's size of farming operations, education, income level, attitude of associates, nature of practice, cost of adoption, and so on.

Further insights about how the community proceeds in adopting a practice are presented. Information as to which types of media are most efficient at various stages of adoption are discussed and should be helpful to educators in planning their educational programs.

The book is readable and thoroughly documented. It would be very useful to anyone concerned with bringing about desirable changes. I would consider it "must" reading for anyone entering extension work at either the State or county level. In addition, it would be a most valuable textbook for teaching extension methods.

Richard G. Ford

Economic Development for Latin America; Papers, Critical Comments and Informal Discussions of Conference Held by the International Economic Association.

Edited by Howard S. Ellis and Henry C. Wallich. St. Martin's Press, Inc., New York. 479 pages. 1961. $10.00.

IN RECENT YEARS an increasingly larger share of research resources in economics has been devoted to investigating the nature of economic growth—its rate, character, and causes—in an effort to develop a workable theory of economic development. To date, the search for a general theory of economic growth has been confined primarily to an investigation of the various aspects of economic development where accepted economic principles can be used to determine the role of given sectors of the economy in promoting economic development. This volume of papers, critical comments, and informal discussions of a roundtable of the International Economic Association held in Rio de Janeiro, August 19–28, 1957, falls into this category. The emphasis of this conference was on theoretical considerations of particular facets of the total problem of economic growth and development. Conference participants from the United States were: P. N. Rosenstein-Rodan, Ragnar Nurkse, G. H. Alter, J. H. Adler, Jorge Marshall, Howard S. Ellis, Albert O. Hirschman, Gottfried Haberler, T. W. Schultz, and Henry C. Wallich.

The title of this volume may be misleading. The editors recognize this in the introduction where they state that: "In the first place, the emphasis is not placed upon the operational problems of economic policy and administration, but upon the theory of economic development and its general application. In the second place, while participants in the conference had in mind particularly the Latin-American scene, the very fact that the orientation throughout was towards theory and general questions of policy signifies that the analysis is not narrowly restricted in a geographic sense. Finally, the Table of Contents reveals that the conference did not attempt to cover all possible issues in economic development but rather those chiefly involved with the supply of capital, and with international economic relations."

The first group of papers deal with the broad issues of theories and methods of achieving development and balanced growth. The major points stressed were that macro-planning is essential for policy formulation; that the historical effects of shocks (wars and depressions) on many Latin-American economies had been beneficial; that the theory of growth is very largely a theory of investment; that growth could be initiated if sufficient efforts were made and capital was available to overcome the indivisibilities of inputs and outputs to achieve economies of scale (the theory of the Big Push); and that inflation must be controlled to facilitate balanced growth.

The second group of papers deal with different aspects of the supply of capital and the role of financial institutions in promoting economic development. The major aspects of development discussed were the relationship between capital accumulation and investment and economic growth; the relation between credit and debt service and economic growth; the relative merits of different financial institutions in financing economic growth and the concept of a desirable ratio between equity and loan financing as well as the merits and demerits of private versus public foreign financing.

The third group of papers were concerned with the different aspects of international trade theory and its relation to development policy, with the risks of primary producers, and with the means for stabilizing foreign earnings. In these papers the questions of whether or not international trade can stimulate economic development in the twentieth as it did during the nineteenth century when the effects of import substitution and product specialization (comparative advantage) on the terms of trade and the nature and rate of development in underdeveloped countries have been drastically altered. This is especially true when development is predicated on export expansion of primary products.

The final group of papers explored the role of different types of investments and their priorities, the relative priorities of agricultural and industrial development, and the possible contributions that exchange controls might make to development.

This volume goes further than most publications of conference papers. Both formal and informal comments on the main papers are presented. I found the critique sections to be most informative. They presented pros and cons of outstanding economists on theoretical approaches to economic de-

velopment problems. This book should serve as an excellent reference text for students of economic development and for policy makers with some grasp of economics, although its best use is for the first group.

The most important contribution of this volume probably is its expert exposure of the complexities and interdependency of the different theoretical considerations embodied in the concept of economic growth and development. It is primarily a problem raiser rather than a problem solver.

Arthur B. Mackie

The Economic Development of Venezuela.

By the International Bank for Reconstruction and Development. The Johns Hopkins Press, Baltimore. 494 pages. 1961. $8.50.

THIS EVALUATION of strengths and weaknesses in the Venezuelan economy provides the basis for recommendations covering a long-term development program with special reference to public investment during the period 1960–61 to 1963–64. Within the limitations of prospective financial and technical resources, the mission attempts to formulate investment priorities which, by broadening and strengthening the economy, will expand employment opportunities and improve living standards for the country's 7 million people.

A general section provides the reader a brief look at the petroleum-oriented Venezuelan economy, government policies, development problems, growth targets, and a summary of the mission's proposals. More comprehensive analyses are presented in later chapters, appended statistics, and special studies including an assessment of petroleum outlook and an evaluation of resources, growth factors, and investment priorities for key economic sectors.

The Economic Development of Venezuela provides an interesting study of problems associated with a rapid shift in economic structure which may be stimulated by intensive development of one or a few resources. Receipts from petroleum exploitation and a protectionist trade policy have provided in the past a favorable climate for private and public investment which is reflected in sustained and rapid growth of consumer goods, and mineral processing, transportation, power, and related commercial activities during the past 25 years. In contrast, development and training of human resources have lagged, encouraging an income distribution which maintains approximately one-half of the population near subsistence living levels. These forces are reflected in the lack of development of the agricultural sector and in a high-cost industrial sector limited to a narrow domestic market.

Recognition of these limiting forces and the uncertainty of Venezuela's competitive position in the world petroleum market are implicit in the mission's proposals, which recommend both a reduction and some reorientation of public investment. Increased priority is recommended for programs in agriculture, health, housing, general education, and technical training, with a reduction in large-scale projects for transportation, power, irrigation, and port facilities.

The study is a sector-by-sector analysis by a qualified mission, conducted within a sound economic framework. Its primary objective is assistance to the Venezuelan Government in formulating policy. It should accomplish this and also provide guidance to others who have responsibility for or an interest in economic problems of developing countries.

Howard L. Hall

Capital and Credit Needs in a Changing Agriculture.

Edited by E. L. Baum, Howard G. Diesslin, and Earl O. Heady. Iowa State University Press, Ames, Iowa. 406 pages. 1961. $4.95.

PROBLEMS of capital and credit represent a somewhat neglected area of the adjustment and economic growth complex facing American agriculture. On this theme, the Tennessee Valley Authority, the Farm Foundation, and the Center for Agricultural and Economic Adjustment at Iowa State University organized and sponsored a symposium at Knoxville, Tenn. The U.S. Department of Agriculture assisted the sponsoring organizations. Twenty-seven papers and 21 discussions were presented. These papers and discussions form this book.

The contents are divided into five parts: (1) Capital and credit in economic growth; (2) changing capital structure in agriculture; (3) credit market and institutions; (4) values and education in relation to capital use and produc-

tivity; and (5) research for improving use and productivity of capital and credit.

The writers of part 1 are concerned with growth problems in agriculture, capital formation, the structure of the capital market, changes in capital productivity in different agricultural regions, and trends in capital. George K. Brinegar stimulates the reader's imagination by his inclusion of people, community facilities, marketing facilities, and technology as capital items.

In part 2, the effects of technology, vertical integration, and agricultural adjustments are related to capital and credit needs. L. A. Jones and Ronald Mighell point out that contract arrangements have helped to bring new capital into agriculture. Land tenure as a factor in capital formation is stressed by Philip M. Raup.

Farm credit institutions and the functioning of the credit market are evaluated in part 3. The discussion of commercial banks, production credit associations, and the Farmers Home Administration include some repetition. Short-, intermediate-, and long-term loans are appraised several times. "Package credit," "balanced credit programs," or "comprehensive credit service," are overlapping suggestions as to ways by which lending institutions can improve the credit situation.

Values, attitudes, and investments in the human factor make up the content of part 4. A better understanding of these factors will help lenders to work more effectively with farmers in using capital more efficiently. Several of the papers are highly technical and theoretical. In fact, two writers provide a vocabulary with special meanings. One of the discussions contains the practical suggestion ". . . that college research workers in cooperation with commercial banks, farm credit banks and associations, and other farm credit agencies develop actual cases which could be written up, studied by students and adult farmers, then discussed and used as a tool to improve decision making abilities and techniques."

The fifth and final part presents selected examples of research on capital and credit problems. William B. Back and Verner G. Hurt conclude that much improvement in capital use by individual farmers could be expected from an effective educational program designed to influence their "knowledge image" of production alternatives.

The editors state that "the contents of this book are directed toward agricultural workers who are conducting research and educational activities in the land-grant colleges, public agencies, and credit agencies, and it is their hope that the information and thinking presented will be useful in developing a rational approach to farm problems and in building a stronger agricultural industry." The book succeeds in presenting a number of new ideas on capital and credit problems. Unfortunately, the technical vocabulary used in several of the more valuable theoretical papers may restrict their use by operating people in finding practical solutions to credit problems. The primary use will be as reference material and to stimulate further thinking.

Frank D. Hansing

Trends in Government Financing.

By Morris A. Copeland. Princeton University Press, Princeton. 210 pages. 1961. $5.00.

PROFESSOR COPELAND'S monograph is part of a larger National Bureau of Economic Research inquiry into the long-term trends and prospects in capital formation and financing in the United States. It is a competent treatment of a difficult subject. His analysis of government finances—State, local, and Federal—brings into focus the factors that have influenced governmental financial actions in the past. The achievement of effective solutions to our current problems requires an understanding of these factors. This book, therefore, will be of interest to economists working in the field of government finance.

Specifically, Professor Copeland's objective is "to determine what borrowings and what capital outlays there actually have been and what circumstances have given rise to them, and by so doing to provide a basis for judging what they are likely to be in the future." He does not attempt to judge the wisdom or the necessity of these capital requirements. The study concentrates mainly on governmental financial capital requirements which are defined as the "actual governmental demand for funds in the loan and security markets."

Professor Copeland then turns his attention toward the reasons governments resort to the capital market. It is necessary to consider the entire governmental budget "for it is really deficits and not particular functional categories of expenditures that have to be financed."

The technical problem of determining the deficit is now presented. Professor Copeland evaluates

various governmental accounting procedures and their objectives, and then chooses the flow of funds nonfinancial computation to analyze government financial capital requirements "because it provides more pertinent information for this purpose than either of the others and because of the financial details it provides."

A historical review of Federal, State, and local government finances suggests the following conclusions: Urbanization of the United States was largely responsible for the volume of State and local debt. In general, there has been a tendency for the per capita gross debt to vary with the size of the community, with the more populous ones having the greatest debt. Regional differences in per capita debt also occur. However, the differences between the larger and the smaller communities, as well as those between regions, have been narrowing, and Professor Copeland believes that they will continue to do so, "particularly if rural communities continue to acquire more urban characteristics."

Professor Copeland also underscores the existence of economies of scale in taxing and borrowing. These economies have resulted in a shift of financial responsibility from local governments to State and Federal governments, as well as from the State to the Federal government. This shift has occurred largely through the use of grants-in-aid.

As for the Federal Government, more than 90 percent of its net debt in 1954 was the result of war emergencies. Nearly all the remaining debt was traceable to countercyclical requirements of the 1930's.

The prospects for debt retirement are dim. Any reduction that occurred in the past "was a by-product of a legislative procedure that was slow in making downward revisions in wartime tax rates." Currently, political and economic pressures are largely responsible for the nonexistence of debt-retirement programs. Whether or not the Federal debt will increase in the future will depend upon the likelihood of future depressions, on the one hand, and the international situation on the other.

Harvey Shapiro

The Marketing of Livestock and Meat.

By Stewart H. Fowler. Second Edition. The Interstate Printers and Publishers, Inc., Danville, Ill. 740 pages. 1961. $7.50.

THE SECOND EDITION of this book remains a general survey of marketing livestock and meat, primarily concerned with "how to do" as well as "what is done." It is a book of extremely broad scope. It draws on a very large number of sources and touches on a multitude of topics. Covered here in broad outline is nearly every aspect of marketing livestock and meat. Essentially, the book is one from which a reader can obtain a bird's-eye view of the scope and importance of marketing livestock and meat in our complex market economy. The author addresses the book primarily to producers, county agents, livestock extension specialists, packer buyers, and commission men. Undergraduate students of animal husbandry and beginning students of marketing should find this presentation of particular interest.

Enlargement and revision of the earlier work are the apparent purposes of this publication, as most of the material in the first edition is retained. The first edition has been brought up to date and enlarged by including changes that have developed during recent years. Additional charts, tables, and photographs have been inserted where appropriate in the text.

This edition has two additional chapters, primarily the results of reorganization. However, the material for the chapters has been enlarged. Chapter XXI of the first edition, Merchandising Meat and Meat Products, has been revised and developed into Chapter XXI, Wholesale Meat Processing and Distribution; Chapter XXII, Retail Meat Processing and Distribution, and Chapter XXIII, Transportation of Meat and Meat Products.

Several sections have been added within chapters; a few sections have been deleted and others drastically revised. A new and helpful section on elasticity of demand for meat appears in this edition; it gives added flavor to the book. Wholesaling and retailing, important segments of the livestock and meat industry, have been given a broader coverage in this edition. At least the author is cognizant of recent and dynamic changes that have taken place at the wholesale and retail levels. Perhaps more emphasis could have been devoted to this area. Also a brief discussion of the wholesale and retail price spreads might have improved these two chapters. However, in a book of this broad context, it is difficult to devote rigorous analyses to all areas.

The author has done an excellent job of bringing together in one authoritative but readable book much of the basic marketing information on livestock and meat. The lack of application of economic principles to issues and problems of marketing (some of them very controversial) probably constitutes the book's most serious shortcoming. The second edition, as did the first, relies relatively heavily on the U.S. Department of Agriculture for many of its charts as well as source of reference material. In the revision of each chapter of this edition the author had the benefit from authorities in the specialized subject areas.

Like its predecessor, the second edition no doubt will perform a useful service and provide a valuable text at academic institutions for beginning students in livestock marketing. It should also serve as a handy reference to anyone interested in marketing livestock and meat. The references appended to each chapter provide a convenient lead for those interested in further pursuit of specific problems in livestock and meat marketing. It is the opinion of this reviewer that this edition will outdistance the performance of its earlier model.

Also like its predecessor, this edition is directed to classes taught in Animal Husbandry Departments. This still leaves an unfilled need for a text for economists, one which deals in an analytical way with the problems facing a highly dynamic industry. Students of marketing grapple with such controversial issues as grading, competition, and transportation rate structures. They need more economic perspective to appraise the claims of those who seek to maintain the status quo and to determine where the public interest lies.

Victor B. Phillips

Statistical Geography.

By Otis Dudley Duncan, Ray P. Cuzzort, and Beverly Duncan. Free Press, Glencoe, Ill. 191 pages. 1961. $6.00.

THE TITLE of this book, while accurate, is somewhat misleading. The authors are sociologists and they have concerned themselves with some of the peculiar problems encountered in analyzing data on an areal basis—problems common to economics, sociology, political science, and geography.

A researcher may undertake areal analysis for one or more of three basic reasons: (1) An interest in geographic distribution or spatial structure for its own sake; (2) a need to account for regional variations in data; or (3) the opportunity to utilize geographic differences in variables to analyze a problem not concerned primarily with space. The authors have described their work as a "pilot investigation of the feasibility" of formalizing and codifying the tools necessary for such analyses.

They acknowledge that the book still leaves much to be done in the way of such codification. However, it does explore many important problems. For example, how does the researcher choose between alternative areal breakdowns when this decision as to mechanics may so radically affect his results? What criteria for regional groupings of areal units are to be accepted? What errors or biases are built in when one uses associations of aggregates in lieu of association at the individual level? How applicable are significance tests and confidence interval estimation procedures to such statistics as coefficients of correlation or regression based on areal data? The book develops much of the mathematical basis for approaching these problems.

Statistical Geography is particularly to be recommended to the many economists in the U.S. Department of Agriculture who use census and other regionalized, aggregative data in both research and operations. Perhaps one of them, drawing upon his trials and errors, will make a further contribution to this important phase of methodology which cuts across so many disciplines.

There is one negative note. While a seemingly adequate bibliography is included, the subject matter indexing is so cursory that it might well have been omitted.

Robert C. Otte

The State of Food and Agriculture 1961.

Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 177 pages. 1961.

THIS year's review of the state of food and agriculture again reveals the general pattern that has become familiar during the last decade—abundance, often a surplus, in the economically more developed half of the world, malnutrition

and hunger in many of the less developed countries. The volume includes a world review and outlook of food and agriculture, and chapters on land reform and institutional changes, agricultural extension, education, and research in Africa, Asia and Latin America, as well as 17 tables and 19 charts.

FAO Commodity Review—1961.

Food and Agriculture Organization of the United Nations. Columbia University Press, New York. 135 pages. 1961.

FAO has customarily prepared this worldwide situation and outlook report for use of the FAO Committee on Commodity Problems, but the document has never before been published in its present form. Following a discussion of the general situation and outlook, these individual commodities are treated separately and in detail—wheat, grains, rice, dairy products, meat, eggs, fats and oil, sugar, cocoa, coffee, tea, cotton, wool, jute and allied fibers, hard fibers, rubber, tobacco, fresh fruit, dried fruit, fishery products, and forestry products. The review is based on information available to FAO up to March 15, 1961.

Production Yearbook 1960.

Volume 14. Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 507 pages. 1961.

ALL important aspects of world food and agriculture are included in statistical data in 180 tables—land, population, index numbers of agricultural production, crops and livestock, food supply, means of production, prices, and wages and freight rates. The yearbook contains information available to the end of December 1960.

Marketing Livestock and Meat.

By R. F. Burdette and J. C. Abbott. Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 209 pages. 1960.

CO-AUTHORS of this report are FAO marketing experts. They explore marketing demands, livestock and meat transport, marketing organizations, pricing and sales methods, public controls and services, and costs, margins, and efficiency. A three-page selected bibliography cites international sources, nine of which are reports of the U.S. Department of Agriculture.

Animal Health Yearbook 1960.

Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 311 pages. 1961.

THE STATISTICS were collected by the World Livestock Disease Reporting Service of FAO. The volume consists largely of tables covering the animal diseases of Africa, the Americas, and Asia. The report, which is fifth in the series, has articles on major changes in livestock diseases, foot-and-mouth disease, bovine pleuro-pneumonia, and accounts on recent veterinary meetings and developments in veterinary research.

Yearbook of Forest Products Statistics 1960.

Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 160 pages. 1960.

THIS fourteenth yearbook, which was compiled by FAO in collaboration with the Economic Commission of Europe, contains more complete information on forest production, trade, and resources than any of its 13 predecessors. Besides giving the salient features of the world situation of forest in world economy, world trade in wood products, and the statistics on sawnwood, plywood, particle board, pulp, pulp products, and teak logs and sawnwood, the volume contains 21 tables that provide detailed statistical data.

Trade Yearbook.

Food and Agriculture Organization of the United Nations. International Documents Service, Columbia University Press, New York. 349 pages. 1960.

Data for most of the countries covered in 93 tables are taken from official publications or supplied by member governments by questionnaire. Besides the tables the yearbook includes discussion of the following subjects: Notes on value of agricultural trade, commodity notes, and country notes covering Europe, USSR, the Americas, Asia, Africa, and Oceania. The report contains information available as of May 1, 1960. It was prepared by the Economics Department of FAO, M. Ezekiel, head of statistics division, and P. V. Sukhatme, director. C. A. Gibbons is listed as editor.

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Universities and Colleges[1]

BIRD, A. R. TOWARD A GENERAL FORMALIZATION OF A MANAGERIAL LIFE CYCLE BY A "SCHIZOPHRENIC" INTERPRETATION OF GAME THEORY. Mich. Agr. Expt. Sta. Agr. Econ. 837, 24 pp., illus. 1961. (Mimeographed.) (Econ. Res. Serv. cooperating.)

Discusses the usefulness of game theory to agricultural economists and other social scientists. A special interpretation is made of one of the simplest formulas of game theory—a two-person, zero-sum game—and is then extended to a two-person, cooperative game.

BOSTWICK, D., ESMAY, J., AND RODEWALD, G. AGRICULTURAL PRODUCTION CREDIT IN MONTANA. Mont. Agr. Expt. Sta. Cir. 233, 15 pp., illus. 1961. (Econ. Res. Serv. cooperating.)

Production credit is discussed in relation to sources, lenders' operations, attitudes of lenders and farmers that affect availability and use, and strategies to use to improve chances of borrowing funds needed.

BOSTWICK, D., ESMAY, J., AND RODEWALD, G. ATTITUDINAL RESEACH RELATING TO FARMERS' USE OF SHORT-TERM CREDIT. U.S. Dept. Agr. Econ. Res. Serv. ERS–25, 23 pp. Oct. 1961.

Factors that affect the availability of short-term credit to dryland farmers in Montana were studied. Guttmanscale analysis, rank correlations, and paired comparisons were used for testing attitudes, and experience with each is reported.

BURK, MARGUERITE C. TRENDS AND PATTERNS IN U.S. FOOD CONSUMPTION. U.S. Dept. Agr., Agr. Handb. 214, 123 pp., illus. June 1961.

Domestic production of farm food commodities, excluding quantities used for feed and seed in each year, increased by three-fourths from 1924 to 1959 while U.S. population increased a little over a half. This study describes sources and uses of food supplies, historical changes in average food consumption, and variations in food consumption among population groups at several points in time. Variations in the use of marketing services over the last 30 years and among population groups are reviewed, as are the historical changes in food consumption in terms of the value of civilian food at several levels of distribution.

COOKE, F. T., JR. AN ECONOMIC ANALYSIS OF FACTORS AFFECTING WATER LOSS IN IRRIGATION CHANNELS IN THE YAZOO-MISSISSIPPI DELTA. Miss. Agr. Expt. Sta. Bul. 626, 7 pp. 1961. (Econ. Res. Serv. cooperating.)

One important cost associated with irrigation is that of pumping and transporting water. The cost of irrigation water that reaches the field is increased because of evaporation and seepage. This study examines the extent of these losses in various soil types in the Yazoo-Mississippi Delta and describes methods of reducing water losses.

DOTY, HARRY O., JR. FATS ADDED TO FEEDS: AN ECONOMIC ANALYSIS. U. S. Dept. Agr. Mktg. Res. Rept. 498, 31 pp. Sept. 1961.

The fats and oils industry needs new outlets for its large supplies, since the volume used in soapmaking has declined as the production of synthetic detergents has increased. The largest single new market for fats and oils is in animal feed. An estimated 1.4 billion pounds of fat could be absorbed annually in mixed feeds and feed ingredients in the next decade.

FABER, F. L., AND PEDERSEN, J. R. RESEARCH TO IMPROVE REPORTING ON EGGS MOVING INTO COMMERCIAL TRADE CHANNELS. U.S. Dept. Agr. Econ. Res. Serv. ERS–11, 24 pp. Aug. 1961.

Summarizes the results obtained in the second phase of a research project designed to improve market news reporting of poultry and egg movements from farms into commercial trade channels at the earliest stage of marketing. The Commercial Poultry Slaughter Report was developed under the first phase of the program, the Commercial Egg Movement Report under the second phase. Both are weekly reports for the continental United States, issued on a current basis by the U.S. Department of Agriculture. The information contained in the Commercial Egg Movement Report assists producers, assemblers, and distributors in appraising current and future market conditions for both table eggs and eggs delivered to breakers.

FARNWORTH, VIRGINIA M. RETURNS FROM MARKETING COTTONSEED AND SOYBEAN OILS IN MARGARINE. U.S. Dept. Agr. Mktg. Res. Rpt. 503, 39 pp., illus. Oct. 1961.

About 12 percent of the total United States consumption of cottonseed oil and 33 percent of soybean oil are used in margarine. This report provides information in prices and price spreads for these oils in margarine at different levels of handling, and also the total marketing margin and farm value of oil. Background information is given relative to the oil extracting, oil refining, and product manufacturing segments of the edible vegetable oil industry.

FOLKMAN, WILLIAM S., AND HAMILTON, C. HORACE. FARMERS AND SOCIAL SECURITY IN NORTH CAROLINA (IMPACT OF THE SOCIAL SECURITY OLD AGE RETIREMENT SYSTEM ON AGRICULTURE AND RURAL LIFE IN EASTERN NORTH CAROLINA). N.C. Agr. Expt. Sta. Prog. Rpt. RS–40, 48 pp. June 1961. (Econ. Res. Serv. cooperating.)

Self-employed farmers are in the seventh year of their Old Age and Survivors Insurance coverage. This report presents the results of interviews conducted in the Rocky

[1] State publications may be obtained from the issuing agencies of the respective States.

Mount (North Carolina) Social Security District during the summer of 1959. The purpose of the study was to determine the extent of participation of farm operators and landlords in the OASI program and to appraise the impact of the program upon farming arrangements and retirement plans.

GRAY, J. R., AND GOODSELL, W. D. CATTLE RANCHES: ORGANIZATION, COSTS, AND RETURNS, SOUTHWESTERN NONMIGRATORY GRAZING AREA, 1940–59. U.S. Dept. Agr., Agr. Econ. Rpt. 1, 42 pp., illus. Oct. 1961. (N. Mex. Agr. Expt. Sta. cooperating.)

Includes data on organization, operations, production rates, investments, prices, costs, returns, problems of management, and production practices of southwestern family-operated commercial cattle ranches.

HARP, HARRY H., AND DUNHAM, DENIS F. MARKET POTENTIAL FOR PROCESSED POTATO PRODUCTS. U.S. Dept. Agr. Mktg. Res. Rpt. 505, 27 pp., illus. Oct. 1961.

The retail market offers the largest potential for expanding sales of dehydrated mashed potatoes and frozen French fries. Four-fifths of the total food supply moves through retail channels, but thus far only three-fifths of the dehydrated mashed potatoes and two-fifths of the frozen French fries are sold through retail stores. The proportion of potatoes used for processed foods increased from 2 percent of the 1940 crop to 24 percent of the 1960 crop; by 1970 over 50 percent may be processed.

HARTMAN, L. M., AND WHITTELSEY, N. MARGINAL VALUES OF IRRIGATION WATER. Colo. Agr. Expt. Sta. Tech. Bul. 70, 28 pp., illus. 1961. (Econ. Res. Serv. cooperating.)

This study consists of a linear programing analysis of farm adjustments to changes in water supply. The main intent of the study was to estimate various incremental or marginal values of water. Land productivity, efficiency of water use, timing and level of water supply, and kinds of enterprises that affect the value of irrigation water were considered and their effects estimated with different assumptions about labor supply.

HAY, DONALD G., AND MCKAIN, WALTER C., JR. AVAILABILITY OF SELECTED HEALTH CARE RESOURCES IN RURAL AREAS OF CONNECTICUT. Conn. Agr. Expt. Sta. Bul. 367, 38 pp., illus. June 1961. (Econ. Res. Serv. cooperating.)

Of all Connecticut physicians in active private practice as of 1960, 92 percent were located in the urban towns and 8 percent in the 105 rural towns, with 16 percent of the total population living in the rural towns. While Connecticut has an advantageous physician-population ratio and most rural areas reported adequate availability of physicians and medical specialists, most rural towns need more registered nurses for private duty nursing, hospitals, and public health nursing.

HEIN, C. J. THE STAKE OF RURAL PEOPLE IN METROPOLITAN GOVERNMENT. U.S. Dept. Agr. Misc. Pub. 869, 21 pp. July 1961.

Describes problems resulting from the spread of city populations into farm areas, and suggests five governmental arrangements that could help meet the needs of the two different groups: City-county consolidation, the urban county, the multipurpose special district, federation, and regional cooperation.

HILL, E. B., AND HARRIS, M. FAMILY FARM TRANSFERS AND SOME TAX IMPLICATIONS. Mich. Agr. Expt. Sta. Spec. Bul. 436 (North Central Regional Pub. 127), 48 pp., illus. 1961. (Econ. Res. Serv. cooperating.)

Lack of information and a reluctance to make long-term decisions have often been obstacles to good transfer arrangements. The authors discuss problems of intra-family transfers, and suggest when and how best to make them.

HOOVER, H., AND CRECINK, J. C. PART-TIME FARMING. ITS ROLE AND PROSPECTS IN THE CLAY-HILLS AREA OF MISSISSIPPI. Miss. Agr. Expt. Sta. Bul. 627, 21 pp. Aug. 1961. (Econ. Res. Serv. cooperating.)

Study indicates that many families use part-time farming as an intermediate stage to move out of full-time agriculture, either to full-time nonfarm work or to retirement. A smaller, though nonetheless substantial, group uses part-time farming as a stage in moving into a semi-retired group of full-time farmers.

JANSSEN, M. R. BEEF COW HERD COSTS AND RETURNS IN SOUTHERN INDIANA. Purdue (Ind.) Agr. Expt. Sta. Res. Bul. 725, 12 pp., illus. 1961. (Econ. Res. Serv. cooperating.)

Financial records kept on beef herds on several farms in southern Indiana from 1956 to 1959 are summarized to determine costs and returns, as well as reasons for differences in success of individual levels of herd management.

JONES, W. W. THE MARKETING OF COTTAGE CHEESE AND FROZEN DAIRY PRODUCTS IN KANSAS, MISSOURI, AND OKLAHOMA. U.S. Dept. Agr. Mktg. Res. Rpt. 504, 24 pp., illus. Oct. 1961

Report presents data on the marketing of cottage cheese and frozen dairy products by 35 milk processing plants. The extent to which graded milk is used for cottage cheese and frozen dairy products needs to be considered in any attempt to improve methods for pricing surplus graded milk.

JORDAN, M. F. FERTILIZER USED ON CROPS AND PASTURE IN ILLINOIS, 1959 ESTIMATES. Ill. Agr. Expt. Sta. AERR–45, 27 pp., illus. 1961. (Mimeographed.) (Econ. Res. Serv. cooperating.)

The 1959 Census of Agriculture reported use of commercial fertilizer on a few specified crops and on all other crops and pasture, by counties. These census data and the USDA statistics of fertilizer use were then used to estimate the acreage fertilized with commercially produced materials and the quantity and per acre rate of each nutrient used on all acres and on irrigated acres for each principal crop in Illinois in 1959.

LOFTSGARD, L. D., AND MILLER, W. G. CONTRACTS AND ALLOTMENTS IN SUGAR BEET PRODUCTION: RED RIVER VALLEY, NORTH DAKOTA. N. Dak. Agr. Expt. Sta. Tech. Bul. 434, 40 pp., illus. 1961. (Econ. Res. Serv. cooperating.)

Analyzes farming conditions that have resulted from Federal control of sugar beet acreages, such as distribution of farm income, variations in the financial position of farmers, opportunities to expand farm ownership and operations, and operating decisions for the farm because of contractual arrangements involved.

MAITLAND, SHERIDAN T., AND FRIEND, REED E. RURAL INDUSTRIALIZATION; A SUMMARY OF FIVE STUDIES. U.S. Dept. Agr., Agr. Inform. Bul. 252, 37 pp., illus. Nov. 1961.

Various studies have been undertaken in an attempt to illuminate some of the social and economic changes that occurred after the establishment of industrial plants in rural communities. This report summarizes data contained in five such studies conducted under joint sponsorship of the U.S. Economic Research Service and the State Agricultural Experiment Stations of Mississippi, Louisiana, Utah, and Iowa.

PAWSON, W. W., BROUGH, O. L., JR., SWANSON, J. P., AND HORNER, G. M. ECONOMICS OF CROPPING SYSTEMS AND SOIL CONSERVATION IN THE PALOUSE. Published cooperatively by Agr. Res. Serv. and the Agr. Expt. Stations of Idaho, Oreg., and Wash., Bul. 2, 120 pp., illus. Aug. 1961.

Shows the income obtainable from alternative cropping systems on a typical farm in the Palouse wheat-pea area and effects of various cropping systems on soil productivity.

PEDERSEN, JOHN R., AND MITCHELL, WILLIAM L. REPORTING SHELL EGG MOVEMENTS INTO RETAIL CHANNELS IN FOUR WEST COAST CITIES. U.S. Dept. Agr. Econ. Res. Serv. ERS–30, 28 pp. Sept. 1961.

Describes methods used to improve the accuracy and coverage of weekly reports on the movement of shell eggs into retail channels. Reports for Los Angeles, San Francisco, and Seattle were revised, and a new report was developed for the Portland-Vancouver market. The revised and new reports are based on an estimated total movement for all firms in a defined commercial universe of egg distributors, both wholesale and retail. They were released to the public for the first time on February 16, 1960.

POATS, F. J., DOTY, H. O., JR., AND ELEY, C. P. COOKED, UNEXTRACTED SOYBEAN MEAL; ITS ECONOMIC FEASIBILITY IN POULTRY FEEDS (PRELIMINARY REPORT). U.S. Dept. Agr. Econ. Res. Serv. ERS–32, 16 pp. Oct. 1961.

Cooked unextracted soybean meal can be used in place of soybean meal and an added "inedible" fat in poultry feeds. However, a satisfactory commercial process for producing it has not been completely worked out, as equipment must be designed with processing costs per unit within the potential.

REGIONAL ANALYSIS DIVISION, ECONOMIC RESEARCH SERVICE, IN COOPERATION WITH FOREIGN AGRICULTURAL SERVICE. THE WORLD FOOD BUDGET, 1962 AND 1966. U.S. Dept. Agr. Foreign Agr. Econ. Rpt. 4, 78 pp., illus. Oct. 1961.

A third of the world's population is free from fear of hunger. But for the other two-thirds, resident in Latin America, Africa and West Asia, the Far East and Communist Asia, the struggle against chronic malnutrition continues. Imports from the countries with adequate food supplies cannot fill the nutritional gap; shortages can be overcome only by increased production within the diet-deficit regions themselves of food or the things that can be traded for food. The problems of low per capita income, lack of chemical fertilizer, and a high ratio of population to land seriously impede progress.

ROGERS, GEORGE B., AND RINEAR, EARL H. COSTS AND EFFICIENCY IN TURKEY PROCESSING PLANTS. U.S. Dept. Agr. Econ. Res. Serv. ERS–26, 11 pp. Aug. 1961.

Seasonal variation in supplies of turkeys is a major factor impeding processors' efforts to reduce their costs. In the 25 processing plants studied, costs of utilities, refrigeration, storage, and overhead declined as plant size increased, but costs of wages, supplies, and other items were higher in large plants than in smaller ones.

SMITH, STEPHEN C., AND BREWER, MICHAEL F. CALIFORNIA'S MAN-MADE RIVERS: HISTORY AND PLANS FOR WATER TRANSFER. Calif. Agr. Expt. Sta. Ext. Serv., 26 pp., illus. June 1961. (U.S. Dept. Agr. cooperating.)

Massive projects are planned in California to move water from areas where it is now plentiful to those where shortages are already a problem. This booklet presents the facts of existing and proposed water plans. Both physical facilities and financing proposals are covered.

STEWARD, D. D. EMPLOYMENT, INCOME, AND RESOURCES OF RURAL FAMILIES OF SOUTHEASTERN OHIO. Ohio Agr. Expt. Sta. Res. Bul. 886, 63 pp., illus. June 1961. (Econ. Res. Serv. cooperating.)

Southeastern Ohio has been designated by the Secretary of Agriculture as one of the areas in which a large number of farm people receive low incomes. Rural households were surveyed to obtain data on the amount and the use of resources of each family, level and source of income, family composition and characteristics, and farm organization and operations, as possible reasons for low incomes.

TAYLOR, M. M. THE CONSERVATION RESERVE PROGRAM IN NEW MEXICO. N. Mex. Agr. Expt. Sta. Res. Rpt. 54, 25 pp. 1961.

Describes the operations of the Conservation Reserve Program and the changes in farming that have resulted from it in selected New Mexico counties where participation is particularly heavy.

TOMPKIN, J. R. RESOURCE USE ON FOUR TYPES OF 160-ACRE FARMS IN WEST CENTRAL OHIO, 1956. Ohio Agr. Expt. Sta. Res. Bul. 885, 20 pp. 1961. (Econ. Res. Serv. cooperating.)

A descriptive summary of "typical" or "most likely" organization of the different types of 160-acre farms in west-central Ohio as found in 1956. The farms were separated into major type-of-farming categories based on primary sources of farm income. Dairy, hog, general livestock, and cash grain are considered.

U.S. DEPARTMENT OF AGRICULTURE. 1962 AGRICULTURAL OUTLOOK CHARTBOOK. Issued jointly by Econ. Res. Serv., Foreign Agr. Serv., and Agr. Res. Serv. 66 pp., illus. Nov. 1961.

The 1962 Chartbook, as the others before it, presents graphically essential economic data designed to help farmers, and the people who work with them, do a better job of planning production and marketing. An innovation is combining domestic and foreign economic data in one issue. First USDA Annual Agricultural Outlook Conference was held in 1923 and first Outlook Chartbook appeared in 1928. Copies of charts and maps are available in individual slides, filmstrips, positive photostats, or photographic prints for use in publications or for meetings or classes.

VOSLOH, CARL J., JR., AND BRENSIKE, V. JOHN. THE CHANGING FEED MIXING INDUSTRY. U.S. Dept. Agr. Mktg. Res. Rpt. 506, 27 pp. Oct. 1961.

Reports findings of a mail survey of feed-mixing establishments in 8 States—Massachusetts, Pennsylvania, Georgia, Indiana, Iowa, Colorado, California, and Washington. About 85 percent of the establishments surveyed were retailing feed. Between 33 and 41 percent of feed retailers in the 8 States sold less than 500 tons a year, and 64 percent of retailing establishments mixed feed on the same premises where feed was retailed.

WHEELER, R. O., AND MCCONNEN, R. J. ORGANIZATION, COST, AND RETURNS; COMMERCIAL, FAMILY-OPERATED CATTLE RANCHES, NORTHERN GREAT PLAINS. Mont. Agr. Expt. Sta. Bul. 557, 20 pp., illus. June 1961. (Econ. Res. Serv. cooperating.)

Gives budget analyses of three sizes of commercial family-operated cattle ranches in the Northern Great Plains. Size classes were defined by the number of animal units on hand January 1, 1959.

WIRTH, M. E., AND NIELSON, J. RESOURCE OWNERSHIP AND PRODUCTIVITY ON MICHIGAN FARMS. Mich. Agr. Expt. Sta. Spec. Bul. 435, 51 pp., illus. Aug. 1961. (Econ. Res. Serv. cooperating.)

Reports the changes farmers made in net worth, income, and capital structure from 1953 through 1958, and analyzes the relationships among these variables.

YOUMANS, E. GRANT. ECONOMIC STATUS AND ATTITUDES OF OLDER MEN IN SELECTED RURAL AND URBAN AREAS OF KENTUCKY. Ky. Agr. Expt. Sta. Prog. Rpt. 105, 43 pp. Oct. 1961. (Econ. Res. Serv. cooperating.)

Men aged 60 and over in an area probability sample of households drawn from rural Casey County and men of comparable age in a random sample of households in metropolitan Lexington were interviewed in their homes. Major environmental conditions examined were economic in nature. Attitudes were inferred from responses of subjects to statements concerning selected life situations.

Statistical Compilations

CLARK, G. W., AND PARTENHEIMER, E. J. COSTS AND RETURNS FROM CROP PRODUCTION IN THE WIREGRASS AREA (LOWER COASTAL PLAINS) OF ALABAMA. Ala. Agr. Expt. Sta. Mimeo. Rpt., 49 pp. 1961. (Econ. Res. Serv. cooperating.)

CROP REPORTING BOARD, U.S. DEPT. AGR. STATIS. RPTG. SERV. CITRUS FRUITS, BY STATES, 1954–55—1959–60, REVISED ESTIMATES. U.S. Dept. Agr. Statis. Bul. 296, 13 pp. 1961.

CROP REPORTING BOARD, U.S. DEPT. AGR. STATIS. RPTG. SERV. FIELD SEEDS, SUPPLY AND DISAPPEARANCE, UNITED STATES CROP YEARS 1939–59. U.S. Dept. Agr. Statis. Bul. 298, 29 pp. 1961.

CROP REPORTING BOARD, U.S. DEPT. AGR. STATIS. RPTG. SERV. FRUITS, NONCITRUS, BY STATES, 1954–59; REVISED ESTIMATES, UNITED STATES, 1949–59; PRODUCTION, USE, VALUE. U.S. Dept. Agr. Statis. Bul. 292, 104 pp. 1961.

CROP REPORTING BOARD, U.S. DEPT. AGR. STATIS. RPTG. SERV. PRICES RECEIVED BY FARMERS FOR CALVES, UNITED STATES AND BY STATES, MONTHLY AND ANNUAL AVERAGE PRICES 1909–1960. U.S. Dept. Agr. Statis. Bul. 294, 61 pp. 1961.

CROP REPORTING BOARD, U.S. DEPT. AGR. STATIS. RPTG. SERV. TREE NUTS, BY STATES, 1954–59; REVISED ESTIMATES, PRODUCTION, USE, VALUE. U.S. Dept. Agr. Statis. Bul. 295, 15 pp. 1961.

GREVE, R. W., PLAXICO, J. S., AND LAGRONE, W. F. RESOURCE REQUIREMENTS, COSTS, AND EXPECTED RETURNS; ALTERNATIVE CROP AND LIVESTOCK ENTERPRISES; ROLLING PLAINS, NORTHWESTERN OKLAHOMA. Okla. Agr. Expt. Sta. Processed Ser. P–390, 41 pp. 1961. (Mimeographed.) (Econ. Res. Serv. cooperating.)

HODGES, E. F. ANIMAL UNITS OF LIVESTOCK FED ANNUALLY, 1909 TO 1959. U.S. Dept. Agr. Statis. Bul. 271, 12 pp., illus. Oct. 1960.

PARSONS, M. S. ROBINSON, F. H., AND STRICKLER, P. E. FARM MACHINERY: USE, DEPRECIATION, AND REPLACEMENT. U.S. Dept. Agr. Statis. Bul. 269, 37 pp. Oct. 1960.

U.S. GOVERNMENT PRINTING OFFICE: 1962

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WITH THIS ISSUE, *Wayne D. Rasmussen* and *Bruce W. Kelly* join the editorial staff of *Agricultural Economics Research*, Mr. Rasmussen as Book Review Editor and Mr. Kelly as Assistant Editor. Mr. Rasmussen is Chief of the Agricultural History Branch, Economic and Statistical Analysis Division, Economic Research Service. Mr. Kelly is Chief of the Research and Development Branch, Standards and Research Division, Statistical Reporting Service.

In addition to new editors we present, with this issue, some modifications in the typography of our journal, intended to improve its appearance and readability.

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